Essays on the economics of British Columbian timber policy

Niquidet, Kurt

ESSAYS ON THE ECONOMICS OF BRITISH COLUMBIAN TIMBER POLICY

ISBN 978-90-367-3121-8
ISBN 978-90-367-3121-1

RIJKSUNIVERSITEIT GRONINGEN

Essays on the economics of British Columbian timber policy

PROEFSCHRIFT

ter verkrijging van de graad van doctoraat in de
Ruimtelijke Wetenschappen
aan de Rijksuniversiteit Groningen
op gezag van de
Rector Magnificus, dr. F. Zwarts,
in het openbaar te verdedigen op
donderdag 25 oktober 2007
om 16:15 uur

door

Kurt Niquidet

geboren op 20 mei 1976
te Williams Lake, Canada

Promotores: Prof. dr. H. Folmer
Prof. dr. J. van Dijk

Beoordelingscomissie: Prof. dr. D. Strijker
Prof. dr. K. Lofgren
Prof. dr. K. van Kooten

Contents

Samenvatting (Dutch Summary)

Ruw hout vormt nog altijd een wezenlijk onderdeel van verscheidene regionale economieën in Brits-Columbia (BC). Het bos als productiemiddel kent een grote rijkdom aan soorten en is zeer gevarieerd in leeftijd, samenstelling en toegankelijkheid (bijvoorbeeld terrein en afstand tot afzetgebieden). De instituties die deze productiemiddelen reguleren zijn al even gevarieerd. Dit is misschien het best te zien in het exploitatiesysteem voor staand hout in de provincie. De provincie kent een grote verscheidenheid aan exploitatievormen, elk met zijn eigen unieke kenmerken, geschiedenis en doelstelling. Deze exploitatievormen hebben met elkaar gemeen dat zij zijn ontwikkeld ten behoeve van een brede schakering aan overheidsdoelstellingen, waaronder het stimuleren van investeringen in de houtverwerkingsindustrie, het scheppen van werkgelegenheid in de bosbouwsector, het behoud van stabiliteit in gemeenschappen, het innen van belasting, het bevorderen van herbebossing en het ondersteunen van duurzame bosbouw op de lange termijn.

Door de jaren heen is het erg lastig gebleken deze doelstellingen op elkaar af te stemmen. Dit werd met name duidelijk in het zachthoutgeschil met de Verenigde Staten (VS). De overheid van BC kreeg alleen toegang tot de Amerikaanse markt als ze kon bewijzen dat ze een 'toepasselijke vergoeding' ontving voor haar hout (hetgeen volgens de VS kan worden aangetoond door het te veilen op open en concurrerende markten) en dat de werkzaamheden in de bosbouwsector onderhevig waren aan marktwerking (VS Ministerie van Handel 2003). De regering van BC ontwikkelde het Forestry Revitalization Plan (revitaliseringsplan voor de bosbouw, hierna genoemd FRP) voornamelijk om aan deze eisen van de VS tegemoet te komen, en hoopte dat de houtindustrie ongehinderd toegang zou krijgen tot de Amerikaanse markt, maar ook dat de industrie flexibel genoeg zou worden om de toegenomen mondiale concurrentie aan te kunnen. De vraag is of deze beleidsveranderingen de belangen van de VS dienden. En zo niet, waarom niet? Hadden ze invloed op de opbrengst en verdeling van houtpacht? Wie profiteerden ervan en wie niet? Waarom gingen de hervormingen niet verder? En bovenal: waarom werden bospercelen die staatseigendom waren niet geprivatiseerd?

In dit proefschrift is getracht een aantal specifieke antwoorden op deze vragen te geven, maar ook is onderzocht welke factoren meer in het algemeen het provinciale houtbeleid aansturen. Dit riep echter weer nieuwe vragen op. Bovendien was het niet altijd mogelijk een volledig antwoord op de aanvankelijke vragen te vinden. Daarom worden in dit hoofdstuk de belangrijkste bevindingen en conclusies samengevat, maar is er ook een sectie opgenomen waarin een aanzet wordt gegeven voor nader onderzoek.

Samenvatting van het proefschrift en algemene conclusies

In de bespreking van de befaamde bosbouwgeschiedenis van Brits Columbia in hoofdstuk 2 wordt aangetoond dat het beleid ten aanzien van de houtproductie in de

provincie voortdurend in beweging is. De ene beleidsmaatregel ging echter veel verder dan de andere of had grotere invloed over een langere periode. Elke grote beleidsverandering leek versneld te worden ingevoerd op grond van veranderende vooruitzichten op de houtmarkt en de eisen die de toenmalige economie stelde.

Rond de voorlaatste eeuwwisseling ontstond grote behoefte aan infrastructuur, omdat BC een enorme volgroeide houtvoorraad bezat en er in andere streken tekorten werden verwacht. Daarom ontwikkelde de provincie in opkomst een systeem van staatsbosbeheer om investeerders aan te trekken voor de ontwikkeling van een binnenlandse houtverwerkingssector. Duurzaam productiebeheer en strengere eisen aan de verwerking zorgden vervolgens na de Tweede Wereldoorlog voor een stabiele aanvoer van hout voor de groeiende, kapitaalintensieve pulpindustrie. Zo werden de regionale ontwikkelingsdoelen van de provincie bereikt en de introductie van nieuwe technologie in de houtzagerijen bevorderd. Door een uitzonderlijk groot volume bestekhout kon de provincie het zich vervolgens permitteren de gerezen milieuvraagstukken aan te pakken.

De omstandigheden veranderden echter. Aan het begin van het nieuwe millennium stond BC voor een geheel nieuwe situatie. De gunstige natuurlijke concurrentiepositie die de provincie te danken had aan de volwassen houtvoorraad verslechterde omdat de toegankelijke voorraden waren geslonken en omdat door technologische vooruitgang (machinale houtbewerking, houtteelt enzovoorts) producten van intensief beheerde soorten met een korte omlooptijd uit andere gebieden in grote hoeveelheden tegen aanzienlijk lagere kosten werden afgezet (Sohngen et al. 1997). Bovendien was de gebruikelijke, op interventie van de provinciale overheid gebaseerde aanpak in de bosbouwsector een voortdurende bron van ergernis voor de handel met de VS. BC werd geconfronteerd met beperkte toegang tot en toegenomen concurrentie op de traditionele markten en kon institutionele hervormingen niet langer uitstellen.

Deze in het FRP vastgelegde institutionele hervormingen werden, evenals vroegere aanpassingen, ingegeven door heersende economische omstandigheden. In dit geval moesten instituties veranderen om de toegang van de provinciale bosbouwsector tot de markt te verbeteren en om efficiënter te worden. In dit proefschrift wordt inderdaad aangetoond dat het FRP en de daarmee samenhangende wetgeving precies dat bewerkstelligde: eindelijk werden hervormingen ingevoerd die een aanzienlijke groei van door bosbouw gegenereerde welvaart opleverden en werd een aantal oude kwesties die samenhingen met het handelsgeschil aangepakt. De belangrijkste veranderingen op het eerste punt betroffen:

1. *Beleidsmaatregelen voor het verbruik* - nieuw 'take or pay' beleid, waarbij de prijs van hout op stam tevoren wordt vastgesteld, neemt de prikkel weg om de productiemiddelen te verbeteren. Dientengevolge waren de noodzakelijke controle- en beheersmaatregelen erop gericht deze scheefgroei aan te pakken. Daarmee kan de correcte intensieve marge worden vastgesteld en zo zal de pachtopbrengst van staatsbos toenemen (zie hoofdstuk 3; Uhler en Morrison 1986; Paarsch 1993).
2. *De gang van zaken bij de houtveiling* - omvang van houtverkoop en concurrentie heeft aantoonbare invloed op de waarde van staand hout in BC (hoofdstuk 4 en 5). De

provincie zal daarom profiteren van het uitbannen van praktijken die de omvang van houtverkoop en concurrentie beperken. Dit blijkt zo te werken bij de verandering van het mandaat en het optreden van het provinciale bureau voor de houtveiling (zie overgang van 'Small Business Forest Enterprise Program' naar 'British Columbia Timber Sales' in hoofdstuk 5).

3. *Maatregelen voor de verwerking* - het gangbare beleid ten aanzien van de houtverwerking, ingebed in verschillende eigendomsstelsels, kost veel geld (zie hoofdstuk 5). De kosten worden veroorzaakt door beperkende bepalingen ten aanzien van de richting van houtstromen of door misstanden ten gevolge van het proces van eigendomstoekenning (waardoor de inzet van te veel kapitaal en te veel arbeid werd gestimuleerd). De nieuwe aanpak van de overheid om pacht te verlenen op basis van prijs alleen en de afschaffing van erfdienstbaarheden waarbij hout afkomstig uit bestaande pachtovereenkomsten gekoppeld wordt aan bepaalde houtverwerkende bedrijven, maakt een einde aan deze kosten. Bovendien blijkt dat de grotere vrijheid om fabrieken te sluiten en eigendomsrechten over te dragen in sommige gevallen op de lange termijn een veerkrachtige bedrijfstak oplevert (zie hoofdstuk 3).

De genoemde hervormingen, tezamen met de prijsbinding voor hout op stam op basis van veilingresultaten, waren ook een eerste vereiste voor de vrije handel met de VS (VS Ministerie van Handel 2003). Dit bleek echter niet voldoende, want op dit moment legt de VS nog steeds handelsbeperkingen op voor zacht bestekhout uit BC. Het is moeilijk te zeggen of het voortbestaan van deze beperkingen te wijten is aan 'ouderwets protectionisme' (McNabb 2005) of aan specifieke kwesties zoals duurzaam productiebeheer, exportbeperkingen voor blokhout en de effecten van prijsbinding voor hout op stam gebaseerd op transactiebewijzen (zie hoofdstuk 3 en 4). Naar mijn mening hebben de hervormingen op zijn minst de onderhandelings- en juridische positie van BC ten opzichte van de VS versterkt.

In het onderzoek in dit proefschrift is ook aan het licht gekomen dat het FRP voor een aanzienlijke herverdeling van houtopbrengsten heeft gezorgd en zowel winnaars als verliezers heeft opgeleverd. Grote winnaar blijkt de provinciale overheid te zijn. Het nieuwe beleid heeft niet alleen meer opbrengst gegenereerd, maar door de open concurrerende houtveilingen groeien ook de inkomsten uit die toegenomen opbrengst.[1] Tot op zekere hoogte ging dit echter ten koste van de bedrijfstak en het arbeidsvolume, omdat de opbrengsten die voorheen werden verspreid direct of indirect aan deze groepen ten goede kwamen. Dit kan als volgt worden samengevat:

- Voormalige verwerkingsnormen die de bestekhoutbedrijven dwongen bestekhout van mindere kwaliteit te verwijderen, werkten opbrengstverlagend. In de pulpsector, vooral die aan de kust, waren de fabrieken echter sterk afhankelijk van dit bestekhout (zie hoofdstuk 3). Op dezelfde manier ging de beschikbare opbrengst van hout uit staatseigendom achteruit door de verkoop van ondermaats hout, maar kregen kleinere producenten weer kansen (zie hoofdstuk 5).

1 Uitzondering hierop vormt misschien de Fort Nelson zone, waar houtveilingen weinig concurrentie ondervonden. Het gevolg kan zijn dat de accijns op staand hout lager is dan de vastgestelde prijs. Zie hoofdstuk 4 voor details.

- Niet geïnde pacht, die niet valt onder het prijsbindingsstelsel voor hout op stam, werd gekapitaliseerd in de waarde van eigendomsrechten in bezit bij de grootste bedrijven. Door nieuwe tarieven voor hout op stam verkregen uit houtveilingen kan het zijn dat bezitters er op achteruitgaan (zie hoofdstuk 3; Binkley en Zhang 1998).
- Arbeid en kapitaal verloren hun waarde, omdat ze door het voormalige proces van eigendomstoekenning indirect de opbrengst van de productiemiddelen claimden. Dit verlies kan invloed hebben op plattelandsgemeenschappen die afhankelijk zijn van de bosbouw, aangezien dit toekenningsproces gebruikt werd om op specifieke locaties arbeid en kapitaal te behouden of aan te trekken (zie hoofdstuk 5).

Onder verwijzing naar de genoemde doelstellingen van het FRP in hoofdstuk 1 kom ik derhalve tot de conclusie dat een aanvang is gemaakt met de realisering van de doelstellingen gericht op het vergroten van het concurrentievermogen, door maatwerk en vrije handel in hout ter verkrijging van de hoogste waarde (exportbeperkingen voor blokhout belemmeren dit proces nog steeds). Niettemin kunnen deze doelstellingen in sommige gebieden en in sommige delen van de bosbouwsector in strijd zijn met de doelstelling van een gezonde bosbouwsector en een gezonde gemeenschap. Ook kunnen zij in strijd zijn met het doel nieuwe deelnemers aan te trekken, want het exploiteren van schaalvoordelen kan nieuwe barrières opwerpen (gereguleerde oogstquota en transportkosten fungeren al als barrière, zie hoofdstuk 4 en 5).

Voortzetting van de in het verleden bepleite decentralisatie gericht op de versterking van private eigendomsrechten op bosterrein (Haley 1985; Zhang en Pearse 1996) zou bovendien, als deze niet nauwgezet wordt ontwikkeld, in strijd kunnen zijn met andere collectieve doelstellingen voor het bos. In hoofdstuk 6 werd aangetoond dat wat wordt beweerd over de ondoelmatigheid van het bestaande pachtsysteem (dat wil zeggen het gebrek aan stimulans om in de houtteelt te investeren) waarschijnlijk is overdreven, aangezien de stimulans voor minimale herbebossing in de private sector zelfs met de zekerste vorm van eigendomsrecht nog klein zou zijn.[2] Dientengevolge zou het gebruikelijke verlenen van rechten op de oogstbare houtopstand, en dus niet op land, in een groot deel van het bosbedrijf in de provincie goed toegepast kunnen worden (dit geldt vooral voor gebieden met een lagere productiviteit in het binnenland en in steile afgelegen gebieden aan de kust).

Op zeer productieve en goed toegankelijke terreinen in beide soorten gebieden waar intensief houtbeheer toegepast kan worden, zou volledige eigendomsrecht grotere investeringen en vernieuwingen mogelijk kunnen maken. Dat zou de druk kunnen verlagen op het aanwezige natuurlijke bos dat haar waarde ontleent aan andere algemene belangen (Binkley 1997). Juist op deze zeer productieve terreinen is ingrijpen in het oogsttijdstip (dat wil zeggen duurzaam productiebeheer) immers zeer kostbaar (zie hoofdstuk 6). De opbrengsten uit duurzame productie zijn echter aanzienlijk geringer op steil, afgelegen terrein met een lagere productiviteit. Vasthouden aan duurzaam productiebeheer in deze omstandigheden kan juist zijn, wanneer rekening wordt

2 Bosbouw omvat aanleg, verzorging en beheer van houtproductie. In hoofdstuk 6 is aangetoond dat bosaanplant (herbebossing) op grote delen van het binnenlandse areaal niet kostendekkend is voor onderhands kapitaal.

gehouden met andere voordelen die niet gerelateerd zijn aan houtproductie, zoals koolstofvastlegging en maatregelen ter bescherming van de natuurlijke habitat.

Suggesties voor nader onderzoek

Naar mijn mening behoeft een aantal kwesties nader onderzoek. Misschien wel de belangrijkste daarvan zijn zaken die relevant zijn voor het zachthoutgeschil. De volgende drie samenhangende categorieën zijn daarbij te onderscheiden:

1. Houtproductie
2. Hout op stamsysteem en houtveilingen
3. Exportbeperkingen voor blokhout

Houtproductie

Om te beginnen zou de door Sedjo (2006) impliciet gestelde vraag kunnen worden beantwoord: hoe zou de houtproductie eruitzien als de private sector een groter deel van de oogstbare houtvoorraad in de provincie in eigendom en beheer had? Zou er worden gekozen voor snellere of langzamere oogst dan bij duurzame productie? Verscheidene auteurs (Nordhaus 1992; Uhler 1991) hebben afgeleid dat de private sector de houtvoorraad veel sneller zou uitputten dan het geval zou zijn bij duurzame productie. Hun intuïtieve oproepen volstaan echter niet, vooral omdat op dit moment wordt afgeweken van het duurzame productiebeleid tengevolge van maatregelen ter bestrijding van de bastkeverplaag in de provincie. Kan deze toegenomen oogst economisch worden verantwoord? Het lijkt mij gerechtvaardigd een uitgebreide analyse van de terreingebonden eigenschappen van houtproductie, de gebruikskosten en de prijseffecten te maken. Als kan worden aangetoond dat duurzame productie (of andere opbrengsttargets) in Canada leidt tot een daling in de houtproductie ten opzichte van een particuliere markt, dan staat het debat over accijns op hout op stam misschien toch enigszins ter discussie (Luckert 2006).

Ook in algemene zin zou dit een interessante onderneming zijn, omdat die past in de paradigmaverschuiving zoals Luckert en Williamson (2005) hebben voorgesteld. Zij beweren, en volgens mij hebben ze gelijk, dat duurzame productie hoge duurzaamheidseisen stelt aan de verkeerde producten van het bos (hout in plaats van zaken van algemeen belang zoals biodiversiteit). Hoe zou de houtproductie eruitzien als die slechts gebonden was aan zaken zoals natuurlijke habitats en landschappelijke kwaliteit en niet aan een gelijkmatige houtproductie? Wat zou het effect zijn op de stabiliteit van de leefgemeenschappen en op de prijzen op de Noord-Amerikaanse bestekhoutmarkt?

Hout op stamsysteem en houtveilingen

Hoe zou het bureau voor de houtveiling in de provincie, de British Columbia Timber Sales, gezien het bovenstaande te werk moeten gaan? Is de beheersmaatregel,

die bepaalt dat er een representatief deel van de totale waarde van de houtproductie in de provincie (alle maten en vormen en onder alle marktomstandigheden) beschikbaar moet zijn, in strijd met het realiseren van marktnabootsende prijsbinding voor hout op stam? Hoe reageren de prijzen voor hout op stam met marktgesteunde prijsbinding op veranderingen in afgeleide producten zoals bestekhout? Resulteert dit in vergelijkbare prijzen en opbrengsten in verschillende stadia van de bedrijfscyclus zoals bij producenten in de Verenigde Staten (Spelter 2006)?

En verder, zou het veilen van 20% van de houtvoorraad voldoende zijn om een concurrerende marktprijs binnen te halen? Zijn veilingtransacties op de vrije markt efficiënte procedures gezien de specifieke aard van de voorzieningen voor de verwerking van bosbouwproducten? Zijn veilingen een geschikt instrument om ruw hout op de markt te brengen in alle regio's van de provincie, de aanwezigheid van schaalvoordelen en hoge transportkosten in aanmerking genomen? Hoe kan de concurrentie voor hout uit BC verder worden vergroot?

Uitvoer van blokhout

In hoofdstuk 4 werd verondersteld dat het antwoord op die laatste vraag in sommige gevallen te vinden is in het afschaffen van de exportbeperkingen op blokhout. Als dit het laatste onderdeel zou zijn dat nodig is om het zachthoutgeschil op te lossen, in welk opzicht zou dan de locatie van de houtverwerking veranderen als er vrije handel was in zowel bestekhout als blokhout? Neoklassieke economische theorie en een eerdere studie (Margolick en Uhler 1992) suggereren dat de provincie in zijn geheel zou profiteren van zo'n verandering, maar dat er zowel winnaars als verliezers zouden zijn. Is enige vorm van compensatie nodig om deze potentiële verbetering van het Paretocriterium te realiseren?

Onderzoek van het proces van institutionele verandering

In het algemeen geldt, dat het niet eenvoudig zal zijn om bovengenoemde verwachte hervormingen via de politiek in te voeren, aangezien er winnaars en verliezers zijn en eerdere pogingen tot hervorming in deze gebieden sterke emoties opriepen bij het publiek (zie hoofdstuk 2). Afwijken van duurzame productie zal onherroepelijk vragen oproepen vanuit allerlei invalshoeken: de houtproductie, de stabiliteit van de gemeenschappen en het duurzaam bosbouwbeheer. Versoepeling van de exportbeperkingen voor blokhout zal worden opgevat als export van banen; hervorming van het pachtstelsel ter versterking van het eigendomsrecht wordt op juridische gronden betwist door de First Nations - het instituut van de leiders van de inheemse bevolking - en de bevolking zal zich zorgen maken over de effecten van privatisering op het nationaal erfgoed.

In sommige gevallen kunnen hervormingen van bestaande instituties niet worden gerechtvaardigd. In andere gevallen echter is verandering en aanpassing vereist, aangezien instituties die vaak werden ingezet in reactie op vroegere omstandigheden niet meer passen in de huidige of toekomstige omstandigheden. Efficiënte aanpassing van instituties lijkt toch het regionaal economisch succes op de lange termijn te verklaren (North 1990). In het algemeen kan derhalve worden gesteld dat de literatuur over de

nieuwe institutionele economie, waartoe North de aanzet heeft gegeven (Ménard en Shirley 2005), zeker kan bijdragen tot verder onderzoek en analyse.

Bibliografie

Binkley, C.S., 1997. Preserving nature through intensive plantation forestry: The case for forestland allocation with illustrations from British Columbia. The Forestry Chronicle 73(5): 553-559.

Binkley, C.S., D. Zhang. 1998. Impact of timber-fee increases on British Columbia forest products companies: an economic and policy analysis. Canadian Journal of Forest Research 28: 617-625

Haley, D., 1985. The forest tenure system as a constraint on efficient timber management: problems and solutions. Canadian Public Policy 11(3): 315-20.

Luckert, M.K., 2006. Property rights, forest rents, and trade: The case of US countervailing duties on Canadian softwood lumber. Forest Policy and Economics 9: 581-590.

Luckert, M.K., Williamson, T., 2005. Should sustained yield be part of sustainable forest management? Canadian Journal of Forest Research 35: 356-364.

Margolick, M., and R.S. Uhler. 1992. The economic impact on British Columbia of removing log export restrictions. In Emerging issues in forest policy, P.N. Nemetz (ed.). UBC Press, Vancouver, Canada.

McNabb, L. 2005. A BC perspective on the softwood lumber dispute. Presentation at the US - Canada forest products trade bilateral technical symposium. Michigan State University, March 7th 2005. Available from http://www.for.msu.edu/trade/ProgramPresentations.htm [accessed 22 March 2007].

Menard, C. and Shirley, M.M. 2005. Handbook of new institutional economics. Dordrecht, Springer.

Nordhaus, W.D. 1992. The impact of stumpage charges on prices and trade flows in forest products, Appendix A to memorandum concerning alleged subsidies and preferentiality in the matter of certain softwood lumber products from Canada. INV. C-122-816. International Trade Administration, US Department of Commerce, Washington.

North, D.C. 1990. Institutions, institutional change and economic performance. Cambridge, University Press.

Paarsch, H.J., 1993. The effect of stumpage rates on timber recovery. Canadian journal of economics 26(1): 107-120.

Sedjo, R. 2006. Comparative views of different stumpage pricing systems: Canada and the United States. Forest Science 52(4): 446-450.

Spelter, H. 2006. If America had Canada's stumpage system. Forest Science 52 (4): 443-445.

Sohngen, B., Mendelsohn, R., Sedjo, R., Lyon, K. 1997. An analysis of global timber markets. Resources for the future. Discussion paper 97-37.

Uhler, R.S. 1991. The great subsidy debate. In Canada United States trade in forest products. Edited by R.S. Uhler. UBC Press, Vancouver, Canada.

Uhler, R.S., P.D. Morrison. 1986. Utilization standards and economics efficiency in British Columbia forests. Forest Economics and Policy Analysis Project. Report 86-1. University of British Columbia, Vancouver.

U.S. Department of Commerce. 2003. Proposed analytical framework for softwood lumber from Canada: Discussion Draft. Washington DC.

Zhang, D., Pearse P.H., 1996. Differences in silvicultural investment under various types of forest tenure in British Columbia. Forest Science 42: 1-8

Acknowledgements

I owe many thanks to several people and groups for supporting me throughout the completion of this thesis. Firstly, I would like to thank my promoters, Henk Folmer and Jouke van Dijk, for agreeing to supervise my research in the first place and for their patient, critical eye which greatly improved earlier drafts of this manuscript. Also, much of the initial work in this thesis was supported financially by the Forest Economics and Policy Analysis (FEPA) research unit at the University of British Columbia. I am grateful for this support and benefited from the ideas and suggestions of Dr. Harry Nelson and Dr. Ilan Vertinsky, who are both members of FEPA and co-authors of chapter five. I am also indebted to my current employer, the School of Forestry at the University of Canterbury, for granting me the flexibility I needed to complete the final sections of the thesis. Moreover, much appreciation to Dr. Kees van Kooten who helped co-author chapter four and initially encouraged me to pursue further study at a doctoral level. Sincere thanks to my family whose support and love has been invaluable, particularly my wife Rhonda and my daughters Olivia and Aleia, who sacrificed much and are dear to me. Lastly, to he who gave me strength (Phil. 4:13).

I. General Introduction

Canada is endowed with a vast forest resource. According to the FAO (2005) there are over 244 million hectares of forest in the country, representing approximately 6.3 % of the world's forest estate. Roughly 200 million cubic meters of roundwood (logs) are extracted from this forest annually. Virtually all of these logs are then processed domestically into higher valued products such as sawnwood (lumber), panelling, and pulp which, for the most part, are then exported to over 175 countries throughout the globe. The value of these exports in 2004 was 44.6 billion, a figure representing about 18% of the world's international trade in forest products, making Canada the world's largest forest products exporter by value (Natural Resources Canada 2007).

Distinctly separating Canada from many other major timber producing regions in the world is its high degree of public ownership, which currently stands at about 94%. Jurisdiction over forest production and policy on these public forests has largely been granted to the 10 Canadian provinces through the Canadian constitution. Each province has its own forest tenure system which governs commercial forest activities on public land (known locally as "crown land") within its borders. In general, forest tenure is a mechanism whereby private forest companies are given rights and access to an annual harvest level on crown land. In exchange for this access, the companies are typically mandated to perform several forest management functions such as forest inventory and reforestation and are often required to operate processing facilities (this is known as appurtenancy). Furthermore, they are charged administered stumpage fees or royalties when harvesting takes place according to a set of complex pricing formulae and are encouraged, through a variety of mechanisms, to generate increased employment and value added in the forest sector.[1] In stark contrast, is the system of forest production in the United States (US), Canada's largest trading partner and the world's principal consumer of forest products. Unlike Canada, commercial forest activities in the US occur mainly on private land where production levels and stumpage prices are market determined. Furthermore, any volume that does originate on US public lands is simply auctioned to the highest bidder. These differences have been at the heart of the disputed softwood lumber trade between the two countries (Sedjo 2006). A dispute that has lingered in spite of several efforts to resolve it through international tribunals at the World Trade Organization and dispute panels put in place as part of the North American Free Trade Agreement, threatening to affect broader trade between the two countries (Biggs et al. 2006).[2]

Much focus has been on British Columbia (BC), Canada's western-most province, as it makes up over half of Canada's softwood lumber exports to the US. This province has

1 Stumpage is simply defined as the price of standing timber.

2 Biggs et al. (2006) outline the several temporary solutions which have been agreed to in the past, most of which involve voluntary export control measures (quotas or export taxes) on the part of Canada. Another temporary 7 year agreement came into force in October 2006, however there already appears to be problems and both countries can opt out of the deal after 23 months (Globe and Mail 2007)

a 95 million hectare land mass where approximately two thirds are forested, an immense area that roughly corresponds to the country of France. Due to steep terrain and low productivity, however, only about half of this forested area is suitable for commercial timber operations.

The provincial government has set up three broad administrative boundaries to govern the forest resource, within which are several sub-regions termed forest districts. The broader regions include the coastal forest region, the northern interior region and the southern interior region; each having differing geography and timber species which has led, to some extent, different forest industries. A map of the province and it's regional and district boundaries along with their associated administrative centers can be found in the appendix.

The coastal forest region spans the entire length of the province's western boundary with the Pacific Ocean and includes two large islands, Vancouver Island and Queen Charlotte Island. The eastern boundary of the region is the height of land of the Cascade Mountain range which runs in a North-South direction up to the state of Alaska and down into the state of Washington in the United States. The prevailing winds heading from the Pacific hit the Cascades and generate very high levels of precipitation – in some case over 5500 mm per year - on its western slopes. This has served to produce a temperate rainforest, of which, the coastal forest region consists. All of the major tree species in the region are commercially valuable, the most important ones being Douglas fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*) and western red cedar (*Thuja plicata*). The lack of a natural disturbance agent like fire has left many parts of this ecosystem in a state of "old growth" where trees are frequently over 500 years old and greater than 50 meters tall. As a consequence, the forest sector in the region has traditionally been geared around extracting large diameter high-valued logs, although second growth harvesting is becoming increasingly important as stocks of economically accessible old growth decline. Much of the terrain on the coast is steep and rugged which makes road building expensive and limits the use of ground based extraction equipment. The majority of timber is therefore extracted with cables and transported via waterways to a relatively centralized processing area surrounding the cities of Vancouver and Nanaimo.

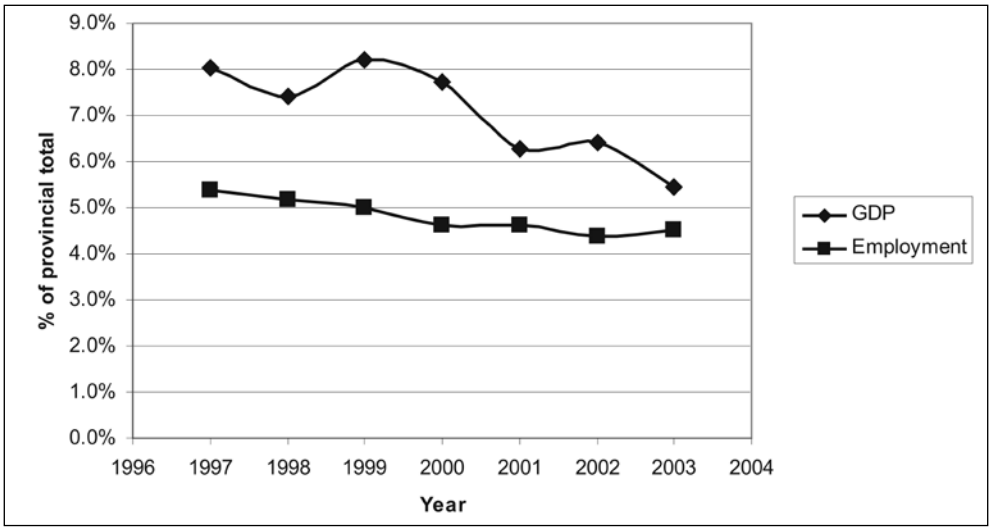
The interior regions by contrast lie on the eastern side of the Cascade Range and run up against the province of Alberta in the east. The northern interior forest region consists of ten forest districts with its headquarters located in the heart of the province at the city of Prince George. The climate in this region is primarily continental, with hot summers and cold long winters, particularly as one heads east away from the influence of the coast. Commercial forests in the region are almost exclusively boreal and sub-boreal, dominated by uniform stands of lodgepole pine (*Pinus contorta var. latifolia)* and white spruce (*Picea glauca*) on rolling flat terrain, which have been influenced by a frequent history of large natural wildfires. The western forest districts, however, retain some coastal influence and contain stands of western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*), and the mountainous areas in the region include sub-alpine species such as Engelmann spruce (*Picea engelmannii)* and subalpine fir (*Abies*

lasiocarpa). The forest industry is primarily oriented towards the mass production of low valued, commodity like, framing lumber which is almost exclusively destined for the United States housing market.

The southern interior region and its twelve forest districts are the most diverse of the three regions. The western edge is situated in the rain shadow of the Cascade Range producing a "dry-belt" forest consisting of open grown Douglas fir (*Pseudotsuga menziesii*) and Ponderosa pine (*Pinus ponderosa*) which is interspersed with native grasslands. The northern part of the region, around the cities of Williams Lake and Quesnel, resemble the northern interior forest region consisting of sub-boreal pine and spruce lying on a flat plateau. As one heads east however the terrain becomes very mountainous and more rainfall develops, producing a very productive interior "wet belt" forest at the base of the mountains which resembles the forests of the coast. This diversity is also reflected in the forest industry, as an assortment of small to medium high-valued operators are mixed with larger low cost commodity producers.

The utilization of this timber resource was initially the backbone of the province's economy. As part of his staples thesis, Innis (1967) described timber as British Columbia's staple commodity, predicting that it would generate most of the economic growth in the province. Hayter and Barnes (1990) argue that Innis' depiction was still a very accurate portrayal of the provincial economy but that the timber resource had reached its peak and economic diversification was necessary to induce further growth. Figure 1 supports the claims of Hayter and Barnes as provincial employment and GDP in the forest sector have been in a state of decline.

Figure 1. Forest Sector's contribution to provincial GDP and employment



Source: Statistics Canada - Labour force survey and CANSIM tables 379-0025 and 379-0026

This diversification however has largely taken place in urban centers like Victoria,

Vancouver and Kelowna which are located in the South island, Chilliwack, and Okanagan-Shuswap districts respectively; three districts which contain approximately eighty percent of the provincial population. As shown in table 1, outside of these urban dominated districts, the forest sector still remains the lifeblood of many rural economies.

Table 1. Direct employment and income in the forest sector by forest district, 2001.

Forest District	Employment (% of total)	Gross Income (% of total)
100 Mile House	27%	27%
Arrow Boundary	21%	18%
Campbell River	21%	20%
Cascades	24%	24%
Central Cariboo	38%	36%
Chilcotin	28%	23%
Chilliwack	5%	4%
Columbia	23%	24%
Fort Nelson	26%	33%
Fort St. James	55%	52%
Headwaters	37%	39%
Kalum	20%	20%
Kamloops	13%	12%
Kootenay Lake	13%	9%
Mackenzie	67%	74%
Nadina	48%	47%
North Coast	21%	25%
North Island/Central Coast	34%	41%
Okanagan-Shuswap	10%	7%
Peace	11%	12%
Prince George	29%	28%
Queen Charlotte	28%	36%
Quesnel	45%	45%
Rocky Mountain	14%	14%
Skeena/Stikine	25%	24%
South Island	8%	8%
Squamish	9%	10%
Sunshine Coast	26%	24%
Vanderhoof	43%	43%

Source: BC Ministry of Forests Economics and Trade Branch. http://www.for.gov.bc.ca/HET/tsr_sea/index.htm

Given the dominate position of timber in the province's rural economy, decisions as to how this immense resource should be used and by whom, have been an ongoing dilemma. Historically, provincial policy makers have generally been sceptical of markets, favouring a command and control approach to timber resource allocation, intervening

often in the forest sector and establishing a web of regulations to shape the forest industry and the communities that depend on them. This approach was particularly evident in the province's forest tenure system which grants timber harvesting rights to private firms on public forestland. Tenure arrangements are without question the government's most powerful policy instrument and throughout time they have been re-structured to meet a variety of changing goals.

Research problem

Recently, the BC forest sector has been facing increasing global competition and restricted access in Japan and the US, its most significant export markets (Bull and Williams 2006). Consequently, facilitating industrial competitiveness and innovation received an elevated status on the government's policy agenda. After reviewing the predicament of the forest sector, Pearse (2001) came to the conclusion that several aspects of the existing tenure system were too inflexible, not allowing the forest sector to adapt to amplified competition in world markets. He was particularly critical of appurtenancy conditions and regulations governing the rate of harvest, but also spoke out about the need for the administered stumpage system to become more sensitive to market conditions.

The BC government, however, faced a difficult task in crafting its policies to meet the needs of its domestic industry without compromising traditional social objectives such as regional job creation and community stability. Further constraining the design of any reform was the enduring softwood lumber trade dispute with the US. Prior tenure instruments aimed either at aiding the competitiveness of the forest sector or meeting social objectives have been the source of subsidy allegations from US producers. This frequently resulted in countervailing trade action on timber stemming from provincially owned forests, limiting BC's access to its prime export market.

In 2003, the BC government hoped it could strike a compromise by formulating a suite of market-based policies termed the Forestry Revitalization Plan (FRP). The plan calls for the increased use of auctions in the allocation and pricing of timber, the re-allocation of timber to small-scale forest tenures, and the elimination of regulations which controlled when, where and what the timber processing sector could produce. The stated goals of the plan and its associated legislation are (British Columbia Ministry of Forests 2003):

- To open the sector to new opportunities, new participants and new ideas;
- Eliminate the regulatory burden and allow the right sizing of operations to increase competitiveness;
- Allow timber to flow where/when it will be put to its highest and best use;
- Maintain a healthy forest sector and healthy communities

The extent the above goals complement or compete with one another is debatable. On the one hand, it is easy to see that these objectives had the potential to clash with one another. The elimination of regulations which constricted the size and location of

the forest industry might allow existing operators to expand and create entry barriers, preventing new participants from taking part in the forest economy; freeing timber to flow to its highest value use could make particular manufacturing facilities superfluous, putting localized jobs and communities at risk; and increasing the forest sector's exposure to market forces may well introduce uncertainty and instability leading to increased risk and capital flight.

On the other hand, a re-structured industry could emerge that is more cost-effective, diversified, and consequently resilient to fluctuations in the global marketplace. This would feed down to the community level resulting in new jobs and greater stability. Furthermore, a new regulatory regime with a greater role for markets might finally put to rest the softwood lumber dispute, providing unfettered access to the world's largest consumer of forest products.

Objectives and methodology of thesis

The aim of this thesis is to examine some aspects of the political economy shaping the design and evolution of timber policy in BC currently. Analysis will primarily focus on the FRP, its intent and some of the effects it has had thus far. For in doing so much of the crucial issues facing policy makers in the province will be revealed and the economic matters surrounding the softwood lumber dispute will be exposed. This will include issues pertaining to timber utilization, the rate and timing of harvesting, and timber pricing. However, my analysis will also seek to uncover why the policy changes stopped where they did. To do so I will draw upon the results of previous studies and will rely heavily on evidence from transactions in the marketplaces for timber and capital. It is hoped this work will highlight areas of future research and influence the direction of future policy.

Thesis outline

One cannot understand the regulatory changes in the FRP and the constraints to further change without having some knowledge of the historical and institutional background of forest policy in BC. I therefore provide a comprehensive historical overview of the political economy which has shaped the development of timber tenure in the province in chapter 2. This chapter culminates by providing a more detailed description of the FRP and a dialogue about notable tenure reforms which had been advocated in the past that did not enter the plan.

In Chapter 3 my empirical investigation into the impacts of the FRP begins. The goal of this chapter is to gain some idea about how the competitiveness and health of the existing forest industry in BC was influenced by the policy changes. To do so, the security prices of 13 publicly traded forest companies operating in British Columbia are analyzed using event study techniques. Such a technique being chosen as it can

convey how the regulatory change has influenced each firm's expected performance from a capital market perspective (in both the short and long run) through actions in the stock market (Binder 1998).

A central component of the new regulatory regime, and a key element of the proposed resolution of the softwood dispute with the US (Spelter 2006), is the expanded use of auctions in the allocation and pricing of timber in BC. A hedonic stumpage model based on interior timber auction results is therefore developed in chapter 4. This model is used to examine the influence of differing regional competition levels on the bids for standing timber. The results are used to discuss the extent to which reduced levels of competition are an obstacle in the design of a market-based stumpage pricing system and the role such a system could play in the dispute resolution process.

Traditionally, the award and operation of forest tenures in British Columbia have been constrained by several regulations designed at meeting a number of regional socio-economic goals. These goals included both the promotion of employment and value added in the forest sector as well as the provision of opportunities for small scale producers and new market entrants. No work however has been done to quantify the efficacy or cost of such constraints. Given that the FRP reduced or eliminated several of these restrictions and that it increased the observable market transactions for several types of tenure, a dataset, pre and post FRP, with varying degrees of tenure conditions and their associated market value became available. This allowed for the estimation of several shadow prices associated with the different tenure conditions. This estimation, as well as the distributional impacts of the tenure changes, is the subject of chapter 5.

In chapter 6, the hedonic model developed earlier is adapted and used to develop the rent gradient for forestland in the interior of the province. This gradient is used to shed light on the institutional framework governing forestland management and silviculture investment in BC. These institutions, while being touted as being severely inefficient (Haley 1985) and at the root of the softwood dispute (Sedjo 2006), have somewhat puzzlingly remained in place after the FRP. This chapter questions and clarifies the results of prior studies which criticised these institutions. While still highlighting the need for change, timber institutions based on the productivity and geography of the land is advocated.

The final chapter summarizes my findings, highlights areas of future research and presents my conclusions and policy recommendations.

References

Biggs, J., S. Laaksonen-Craig, K. Niquidet and G.C. van Kooten. 2006. Resolving Canada-U.S. Trade Disputes in Agriculture and Forestry: Lessons from Lumber. Canadian Public Policy. 32:143-155.

Binder, J.J. 1998. The event study methodology since 1969. Review of Quantitative Finance and Accounting 11(2):111-37.

Bull, G. and Williams, J. 2006. The BC forest products sector in a globally competitive market: developing a strategic response. BC forum on forest economics and policy. SP 05-06. Available from http://www.bc-forum.org/publications.htm

British Columbia Ministry of Forests. 2003. Forest Revitalization policy change legislation overview. Ministry of Forests, Victoria.

FAO. 2005. State of the World's Forests: 2005. Food and Agriculture Organization of the United Nations, Rome. [online]. Available from http://www.fao.org/docrep/007/y5574e/y5574e00.htm [accessed 16 March 2007].

Haley, D. 1985. The forest tenure system as a constraint on efficient timber management: problems and solutions. Canadian Public Policy 11(3): 315-20.

Hayter, R. and Barnes, T. 1990. Innis' Staple Theory, Exports, and Recession: British Columbia, 1981-86. Economic Geography 66 (2):156-173.

Innis, H.A. 1967. The Importance of Staple Products. Approaches to Canadian Economic History. Edited by W.T. Easterbrook and M.H. Watkins. McClelland and Stewart, Toronto, Canada.

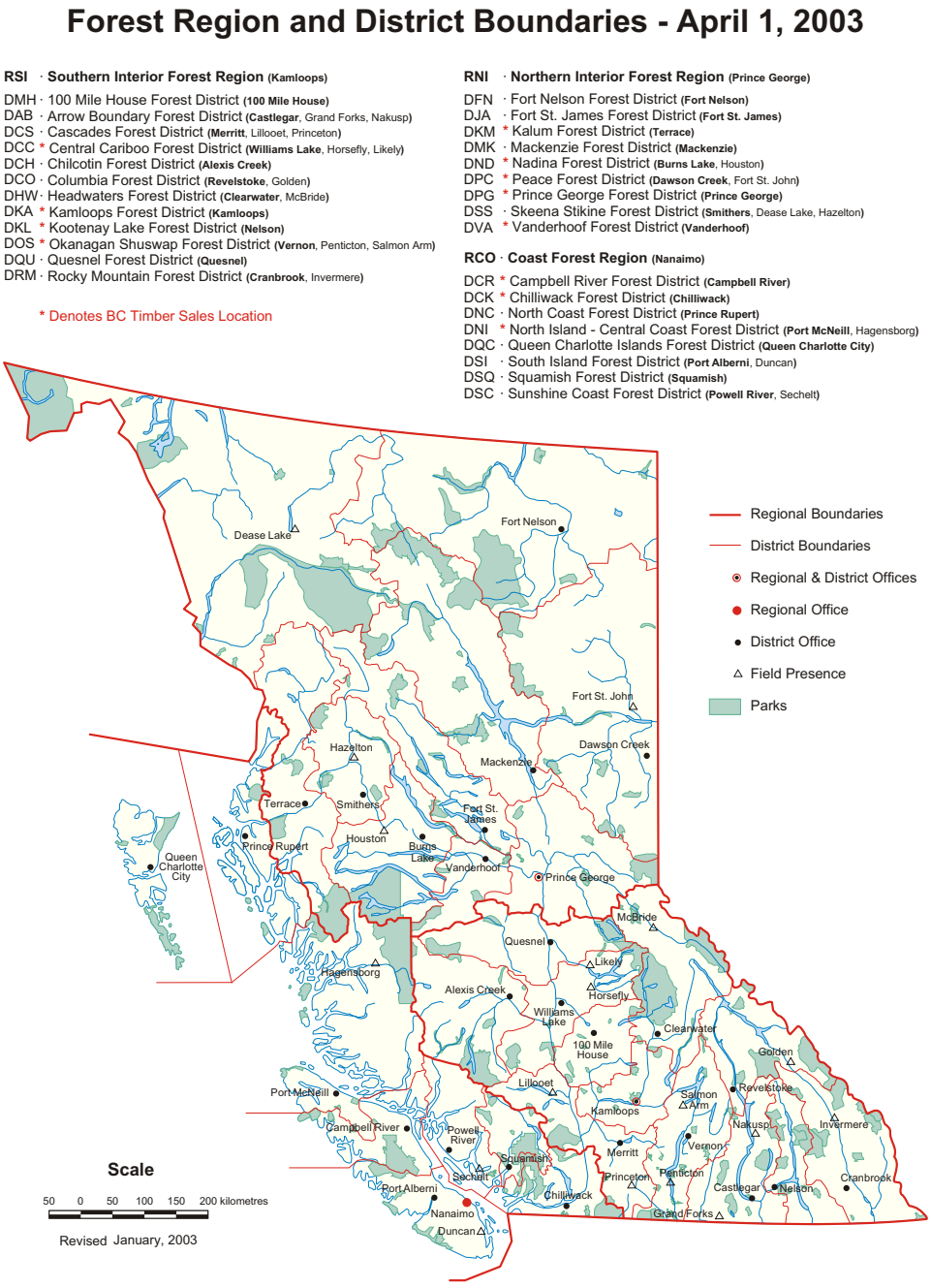
Natural Resources Canada. 2007. Statistics and facts on forestry. [online]. Available from http://www.nrcan.gc.ca/statistics/forestry/default.html [accessed 16 March 2007]

Pearse, P.H. 2001.Ready for change: crisis and opportunity in the coast forest industry. A report to the Minister of Forests on British Columbia's coast forest industry. Vancouver.

Sedjo, R. 2006. Comparative views of different stumpage pricing systems: Canada and the United States. Forest Science 52(4): 446-450.

Spelter, H. 2006. If America had Canada's stumpage system. Forest Science 52 (4): 443-445.

Appendix. Forest Regions and Districts in British Columbia



Source: BC Ministry of Forests and Range website http://www.for.gov.bc.ca/mof/maps/regdis/

II. Historical and Institutional Background[1]

The birth of regulation

Early in the development of BC's forests the concern over the ability of the market to meet the goals of the province was evident. Like that of its American neighbours, originally the crown colony alienated timber land in fee simple.[2] At the time, land and timber were seemingly an endless resource, supplying small local markets. Hence it was usually sold for nominal rates or simply granted in exchange for the development of infrastructure like railways. With the completion of the trans-national Canadian Pacific Railway in 1885 additional markets were opened up which had the effect of vastly increasing the demand for BC timber. At this time some notion of timber scarcity developed and its price consequently rose.

The province began to re-structure its policies with the goal of developing a domestic timber processing sector. The *Land Act* of 1888 set out an area specific leasing system to accomplish this task. Leases were issued on the condition that one construct and operate a manufacturing facility. The lease granted timber harvesting rights over a defined area of land for a specified term (originally 30 years but later dropped to 21 years). Once timber had been harvested, the area was removed from the lease and reverted back to the province. Leases were subject to a fixed rental (per acre) and royalty fee (per million board feet of timber removed) but these fees were generally set low to encourage milling capacity increases. The manufacturing condition was later dropped, but incentives for processing still existed by providing lower royalties to those who continued to operate a facility. Furthermore, in 1891 laws were passed which stipulated that timber derived from provincial lands must be processed within the province, a condition which remains in place today.

As the manufacturing sector developed, a new goal emerged: the collection of revenue for the provincial treasury. New leases began to be competitively bid in 1892; theoretically the bid would reflect the expected discounted value of any resource rents that would accrue throughout the life of the lease that were not collected by the pre-determined rental and royalty fees. Nevertheless, as summarized in the 1910 report of the Royal Commission of Inquiry on Timber and Forestry chaired by Fred Fulton (Hereafter called the Fulton Commission) there appeared to be a general disbelief in the ability of the market to do this.

> "Because great changes might be at hand that would cause stumpage prices to rise beyond all normal expectation, it was felt that to part with timber at the low existing

1 Much of the information in this section is derived from the reports of the Public Commissions on Forestry led by Fulton (1910), Sloan (1945, 1957), Pearse (1976) and Peel (1991).

2 Fee simple ownership is often found in common law countries. It affords the title holder absolute ownership of real estate, although ownership is technically limited by basic government powers such as taxation and eminent domain.

prices and upon the fixed conditions of 21-year leases was a poor way of drawing immediate profit from the immense idle area of Crown forests."

The share of revenue was not the province's only concern either, they were also still mindful of the health of the forest sector and it was thought that the requirement for investors to pay large up front sums for standing timber would draw funds away from a firm, preventing it from investing in working capital and circulating high wages (Ross 1912). The above thinking led to the abolishment of the leasing system in 1905, it presumably was also part of the logic that led to the outright ban placed on the further privatization of timber land in fee simple in 1896.[3] The province was left with a dilemma as to how to maintain a share in the expected rising values of timber without discouraging the growth of the forest industry.

A system of licenses was chosen as the method to meet these dual goals. "Special Licenses" were created also by the *Land Act* of 1888 but were primarily designed for independent loggers free from the condition to operate manufacturing facilities. Like leases they granted rights to timber over a defined geographical area and were subject to rental and royalty rates, but were for much shorter terms (typically a year) with options for renewal. For a short time, licenses had the same fees as leases; however, rental rates were increased successively in 1901 and 1903 reflecting the governments increasing desire to collect more revenue (Pearse 1974). In 1905, upon the abolishment of the leasing system, a new licensing system was implemented. The new licenses continued to be area specific but began to resemble leases as their terms were increased to 21 years. The key difference being that government could adjust royalty rates at will to reflect changing stumpage values. In spite of the uncertainty over royalty rates, these new licenses were highly sought after, increasing in number very rapidly (quite possibly out of speculation over the ability of government to collect the increasing value of the timber). The rapid increase in the number of licenses prompted fears of an ensuing timber famine. A reserve was placed on the issuance of new licenses and the Fulton commission was appointed to explore the new licensing system and to give direction to future policy.

Anticipating further rises in stumpage due to increasing demand and dwindling stocks in eastern North America, the Fulton commission thought that the new licensing system was "ingenious" and concluded that "heavy taxation need never fall upon the population of the province". Yet, the commission also had several concerns over forest practices such as utilization, the rate of cut, and reforestation. The recommended solution to these problems – and that adopted by the province in the 1912 *Forest Act*- was regulation. Merchantability standards were put in place which would eliminate "waste" and promote natural regeneration, the reserve on the issuance of further licenses was maintained and future supplies would be regulated by the Forest Service through the auctioning of small volumes known as Timber Sale Licenses (TSLs).

3 Timber land was defined as lands carrying 8000 feet of timber west of the Cascades range (i.e. the Coastal Region) and 5000 feet east of the range (the Interior).

In hind sight, it is not clear why the timber processing sector could not have developed rapidly under a privatized forest landscape. Moreover, in maintaining public ownership appropriate market instruments, opposed to costly regulations, could have also offered solutions to the problems outlined by Fulton. A prime example is that of utilization. The mechanism used to collect rent from leases and licenses was a uniform fixed royalty per unit of timber removed. It is now commonly known that this method encourages high-grading leading to a deadweight loss of rent (see for example Nautiyal and Love 1971, Vincent 1990).[4] Consequently, it is likely that the source of the wasteful "butchery of wood" described by Fulton and attributed to market failure caused by the carelessness of lumbermen, was, at least in part, due to the instrument chosen to collect the resource rent. There was also a genuine market failure at work, as there was an external benefit to the removal of timber to reduce the risk of fire and to promote the regeneration of the next crop. However, in principle these market failings could have also been addressed by assigning property rights to future crops and adjacent stands. The tendency to prescribe and address problems through the creation of new regulations was a trend that would continue.

The rise of sustained yield management

By the mid 1940s timber from existing area based licenses and leases were dwindling and the forest industry needed to rely increasingly on competitive bid short-term Timber Sale Licenses (TSLs) managed by the forest service. An emerging capital intensive pulp sector was requiring assurances of future supply. Another royal commission was convened chaired by chief justice Gordon Sloan (hereafter the Sloan commission).

Sloan recommended a system of sustained yield (SY) management where harvesting of existing mature timber supplies would be rationed in a planned manner over a rotation until second growth crops emerge. The objective of SY management was to produce a "normal forest" where balanced areas of each age class were to be spread across the landscape. In the long run this would produce a constant supply of timber in annual or periodic increments. The Hanzlik formula (see equation 1) was chosen as a means of setting Annual Allowable Cuts (AAC) for this purpose.

$$[1] \quad AAC = \frac{V_m}{t} + MAI_i$$

Where t is the rotation age that maximizes the Mean Annual Increment (MAI), V_m is the stock of mature timber whose age is greater than t and MAI_i is the growth of timber less than t.

4 The fixed royalty increases the marginal cost of the logger, making lower grade logs uneconomic. The logger therefore tends to only take the best logs in these circumstances (i.e. high-grading). While the government collects some rent with this royalty, the logger still receives a windfall on the better logs. Furthermore, rent is available on the lower grade logs but since there is no incentive to remove these logs because of the royalty, the rent is not collected by the government or the logger (i.e. deadweight loss).

If the land base consisted entirely of mature timber, which was often the case in remote undeveloped regions, the Hanzlik formula allowed for the harvesting of $1/t^{th}$ of the stock of mature timber. This meant that at the end of t years the entire stock would be liquidated just in time for the maturation of the first second growth crops. After that point, harvests would equal growth (MAI_t), which would correspond to a maximum sustained yield steady state. If the region initially contained some immature forests, the stock of old growth could be drawn down quicker according to the growth of that immature stock. Indeed, if one could increase the MAI_t, either by bringing more land into the forested land base (afforestation) or by silviculture activities in immature stands, this would allow the stock of mature timber to be depleted faster, a phenomenon known as the allowable cut effect (ACE). In forests regulated by SY, ACE drives the investment decisions in forest management activities. These decisions can appear perverse, as projects on individual tracts of timberland that would normally be deemed uneconomical would be worth it simply because they lessened the constraints put in place by SY on the rate at which the mature timber was liquidated. Another striking feature of the Hanzlik formula is its lack of economic variables. While the identification of the mature stock of timber took into consideration some economic conditions (this will be discussed later in chapter 6), the timing of t and the rate the mature stock was cut, was solely determined by physical criteria.

Sloan's rationale for recommending SY was certainly not entirely void of economics though. He thought that dividing the province into regional "working circles", with each region regulated via SY, would be an important driver of regional economic development, particularly in the undeveloped hinterlands of the province. It was thought that by providing a stable, perpetual supply of timber for a given region, investment and community stability would follow, preventing "ghost towns" from emerging as areas were liquidated and industry moved onto the next region.

The 1947 *Forest Act* implemented the recommendations of Sloan establishing two types of working circles across the province; one to be managed by the public and later termed Public Sustained Yield Units (PSYUs) and the other to be managed by private firms in perpetuity under an arrangement called a Forest Management License (FML).

Unfortunately, the allocation of FMLs was based on the discretion of the Minister of Forests. As one could image, this set the stage for rent seeking on the part of the forest industry. Although it was not a requirement that applicants own a mill prior to their application, government policy was that first consideration would be given to existing operators and those that proposed to build new plants or expand existing operations. Upon award, the FML was usually made appurtenant to this manufacturing facility such that the facility could not be sold separate from the license and the license would be revoked if the facility was shutdown.

Controversy over the procedure and allocation of FMLs led to the appointment of Chief Justice Sloan for a second inquiry in 1956 (Drushka 1999 p. 44). During the inquiry, the first Chief Forester of the province and then head of BC's largest forest company, H. R. MacMillan, appeared before the Commission to voice his concerns about the potential for concentration and consequent deleterious effects that could take

place under a forest management system that relied on large FMLs. Shortly thereafter, the Forest Minister at the time, Ray Sommers, was charged and convicted of taking bribes in the allocation of FML#22 to BC Forest Products. Sloan's report in 1957 attempted to clarify how licenses were to be awarded and also led to the conversion of FMLs to Tree Farm Licenses (TFLs).

A TFL rather than being perpetual now carried with it a reduced term of 21 years but had provisions for renewal provided certain management conditions were satisfied. This reduced term was put in place largely to address public concerns over the degree of privatization the tenure offered. The management conditions associated with the TFL included forest inventory, growth and yield analysis, development planning and reforestation. Stumpage fees were set by an administered appraisal process which accounted for the costs of forest management borne by the TFL holder.

Within the public working circles, the PSYUs, the forest service initially continued a program of competitive auctions where volume from specific locations was awarded to high bidders via short term TSLs. In the interior a large number of small "bush mills" were established close to each license, cutting rough lumber which was then shipped to larger centers to be planed and distributed. Although competition was fierce, many of these mills were thought to be wasteful, producing large amounts of sawmill residues (due to large saw kerf) and as a result, low lumber recoveries per volume of roundwood. Furthermore, large tracts of lodgepole pine were viewed as "weed species" unsuitable for sawmilling because of their small size. Prospective investors were interested in developing an interior pulp industry, but, again due to large fixed capital costs, were requiring assurances of supply. The "wasted" volume was seen as a means of providing this supply.

Existing TSLs in the 1960s began to be renewed without competition and additional volume was granted provided that the license holder commit to higher utilization standards (termed close utilization or third band utilization) and with the provision that they offer wood chips to pulp mills. As a result, stumpage fees were no longer competitively determined but needed to be administered through an appraisal process. As an added security, the government also issued a new form of tenure – a pulpwood agreement (PA) – to those who constructed a pulp mill. The PA authorized the license holder to extract additional volume from the PSYU to make up for any shortfalls not provided by sawmills and other tenure holders.

This commitment to higher utilization resulted in an immediate increase in the stock of merchantable timber in inventory which as shown in equation 1 resulted in an increased AAC for the PSYU and the license holders. Most operators committed to this standard or sold their license to someone who would commit to the new utilization standard. Furthermore, the government encouraged licensees to consolidate their TSL volumes into a new longer term, volume-based licence called a Timber Sale Harvesting Licence (TSHL) which formalized for the operator a "quota" of AAC at an undefined location within the PSYU. The TSHL – similar to a TFL – was usually appurtenant to a timber processing facility and also brought with it increased forest management responsibilities such as basic silviculture (i.e. reforestation) and development planning.

The cost of these management duties however would be offset through stumpage allowances.

Additional volume in the PSYU not allocated to existing operators was placed up for auction in the form of TSLs and TSHLs. Still, bidding on these new volumes was often restricted to those who would either add or increase certain types of manufacturing capacity. The processing requirements became so important that at times licenses were awarded not solely on the basis of price but also on what the proposed new capacity would offer in the way of utilization, jobs and other socioeconomic benefits. Faced with both regulatory and market incentives to utilize more fibre, operators adopted new sawmilling technology which enhanced the lumber and chips recovered from each log and made the processing of small logs economical. Consequently, pulp mills rarely had to exercise their PA rights. Smaller bush mills became obsolete and the sawmill sector moved into towns, consolidating and integrating with planer mills, lumber distributors and pulp mills.

The SY system, judged according to the goals it was designed, appeared to be very successful. The guaranteed supplies of timber facilitated investment in the centres tributary to the working circles, promoting a world class modern processing sector with enhanced utilization that provided stable revenues to government in the form of stumpage fees and to communities in the form of high paying wages. Nevertheless, success came with a price. Competitive bidding for stumpage was virtually eliminated from the province and the full allocation of AAC created significant barriers to new market entrants. Accusations that administered stumpage fees failed to collect resource rents ensued and the tenure system with all its different forms and individual conditions became an escalating regulatory headache. The idea that community stability was primarily achieved through constant supplies of timber led to cut control regulations which placed both a ceiling and a floor on the amount of volume harvested in each year. Faced with the prospect of losing their tenures if minimum harvest targets weren't met, licensees potentially could act perversely, removing uneconomic timber simply to maintain the target. Moreover, old growth stands gradually became increasingly scarce as they were liquidated and converted to plantations. Subsequently, non-timber values associated with these stands rose steadily and demands for their sustainability were voiced.

The Pearse commission

To address the growing public apprehension over the direction of forest policy, a forest economist at the University of British Columbia, Peter Pearse, was appointed to lead another royal commission in 1976. Pearse issued a series of recommendations which attempted to address many of the concerns listed above. He confirmed that the ownership of forests should remain in public hands, giving the government the power to continue to shape economic development and provide public goods stemming from forests. The caveat however, was that policy was designed so that this power is "well

used". In his opinion, the tenure system was encouraging a vertically integrated industrial structure which did not necessarily parallel that of an efficient market and that increasing consolidation of public harvesting rights was of "urgent public concern". He therefore recommended that competitive markets for stumpage be re-introduced by auctioning off AAC in the PSYU not already allocated in the form of TSHLs. Furthermore, once TSHLs expired he suggested that the volume should be converted into longer termed Forest Licenses (FLs) whose award would no longer be determined by non-price criteria, but instead sold to the highest bidder.[5] In addition, he questioned the wisdom of uniform close utilization standards across all stands regardless of the corresponding economics of extraction and noted the potential distortion current stumpage fees have on utilization decisions. Thus he recommended that standards be made more flexible and that stumpage fees be implemented in such a way that the proper economic margins be maintained.

Additional recommendations from Pearse's report included:

- Further rationalization of the overabundance of tenure types and multiple terms and conditions associated with outstanding area based leases and licenses issued prior to 1907 (termed old temporary tenures). To accomplish this, old temporary tenures should be merged into a single Timber Licence (TL) with common terms and royalty rates.
- The amalgamation of PSYUs into larger Timber Supply Areas (TSAs) reflecting the economics of transportation.
- Opportunities should be made available for small scale forestry via an area based woodlot license (WL).
- TFLs should be made "evergreen", meaning that they would be replaced every 5 years in conjunction with management planning, and given an extended term of 25 years.

He further suggested that in order to meet the demands of the public, management planning in both working circles had to formally recognise other non-timber values such as fish and wildlife, recreation, and water. Pearce rejected the traditional argument that sustained yield management would accomplish this by default. He also noted that SY was not a necessary or sufficient condition for achieving its primary objective of community stability, and warned of the "fall down" effect in AACs once the stock of mature timber was liquidated and supplies consisted of lower volume 2nd growth.[6] Accordingly, timber supply should no longer simply be derived from Hanzlik's formula but would need to take advantage of complex computer simulation which optimized a variety of multiple use goals.

5 Pearse did however suggest that the previous holder of the TSHL be given the right to match the high bid on the FL.

6 The fall down effect refers to the fact that at first the mature "old growth" timber being harvested would have a volume per hectare that was greater than second growth crops harvested at the maximum sustained yield rotation age. The fall down occurs when $\frac{V_L}{t}$ is harvested and removed from equation 1.

The concern over the lack of competitively driven stumpage rates and the critical view of existing yield regulation also found support in academic circles. Anthony Scott (1976) proposed that BC auction at least 20 % of the AAC as a means of setting administered stumpage fees on harvests from long term tenures and Nobel Laureate economist Paul Samuelson (1976) criticized SY for ignoring large opportunity costs and its creation of perverse land management decisions. Byron (1978) on the other hand, rather than investigating the costs of SY, questioned its ability to meet its primary goal. In his analysis he showed that SY in itself could not guarantee the permanence of forest dependent communities, demonstrating that the economics of transportation and processing as well as exogenous market conditions largely shaped forest dependent communities with or without SY. In consequence, he recommended that diversity was a more fruitful mechanism for achieving the community stability sought by SY.

Consistent with tradition, many of the recommendations flowing from Pearse's report were subsequently adopted into an amended *Forest Act* in 1978. The plethora of conditions associated with the various old temporary tenures was rationalized into a common TL and PSYUs were amalgamated into larger TSAs whose delineations remain relatively unchanged to this day.[7] In the hopes of providing incentives for long term forest management "evergreen" provisions were made on both the new FLs and TFLs, and the forest service was mandated to consider a host of other forest values.

Nonetheless, the legislation largely failed to address Pearse's concerns over consolidation and did little to promote increased competition and economic efficiency in future timber disposal and use. Within TSAs allowable cuts were almost completely allocated in the form of FLs, as TSHLs were rolled over largely without competition and without loss of volume. Furthermore, when a new FL was issued it continued to be based on utilization and employment criteria. In 1980, a Small Business Forest Enterprise Program (SBFEP) was created to auction TSL volume to smaller independent market loggers (category 1) and manufacturers who had no tenure (category 2), however the volumes made up a very small percentage of the AAC. With the lack of a competitive stumpage market, complex residual value appraisal methods continued to be used to assess stumpage fees. Lastly, while additional non-timber constraints were put in place, SY which imposed cut control and utilization restrictions that were insensitive to economic conditions continued to underlie the management philosophy.

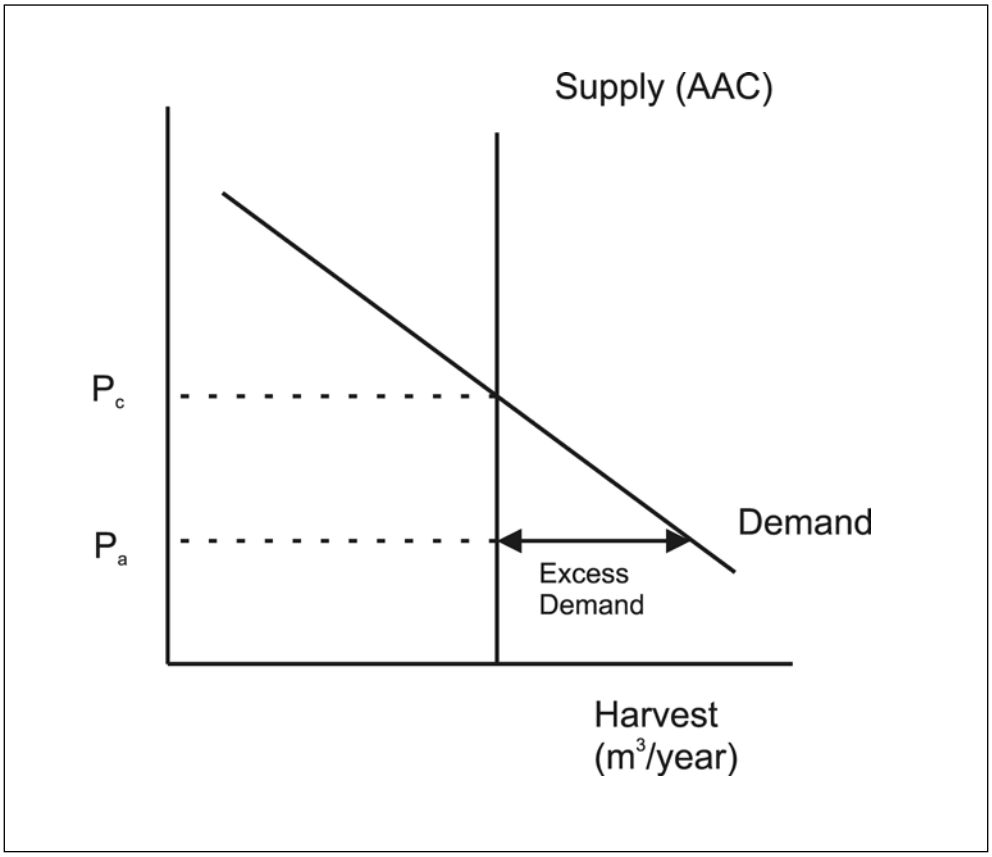
Lumber, labour and environmental disputes

Much of the newly added environmental constraints were relaxed as a prolonged recession hit the North American economy in the early 1980s. Deep staff cuts in the BC forest service took place and a smaller "sympathetic administration" turned a blind eye to deleterious forest practices. Utilization standards were not strictly enforced and several large, unsightly clearcuts appeared on the landscape.

7 For the most part, the boundaries of the TSAs are the same as the forest districts outlined in Appendix 1.

The recession led to many shutdowns in the United States (US) sawmilling sector. Americans placed the blame on an increasing Canadian (particularly BC) share of the US domestic softwood lumber market. American producers attributed this rising market share not to natural competitive advantage resulting from access to an abundant high quality resource and an efficient processing sector, but to subsidies derived from the characteristics of BC's tenure system, particularly its administration of stumpage fees.[8] The American producers petitioned the Department of Commerce (DOC) for countervailing action in 1982. Initially the DOC rejected their claims but this was overturned in 1986 resulting in a 15 per cent tariff on Canadian lumber destined to the US. Uhler (1991) analysed this "great subsidy debate" and the DOC findings, arguing that Canadian administered stumpage fees (p_a) that were lower than a competitive market (p_c) would not raise Canada's share in the North American lumber market. With his argument (summarized in figure 1) hinging on the fact that timber supplies in Canada are fixed as a result of the regulated AAC calculated by the SY paradigm.

Figure 1 Competitive and administered prices in a timber market



8 A study by Haley (1980) showed that there were substantial differences between competitively derived stumpage fees in Washington State compared to those administered in British Columbia.

Although, lower stumpage fees would create an excess demand for timber, ultimately whether fees are set administratively or through a competitive market, production levels will remain unchanged at the AAC. Uhler, therefore concluded that countervailing duties were not justified as Canadian stumpage systems could not be linked to higher production and hence injury to US producers. However, he made little mention as to what an appropriate supply level was, as supply in Canada under SY, unlike that of a market, did not reference price.

To thwart the imposition of countervailing duties (CVD), the Canadian government agreed to impose a 15% export tax on softwood lumber shipments, thus keeping the revenue within Canada. In 1987, the residual value stumpage system was replaced by the Comparative Value Pricing system (CVP), a target rate system tied to lumber and chip value indexes. Although the CVP resulted in stumpage fee increases which replaced the 15% export tax and significantly increased revenues to the provincial government, it contained no mechanism to recognize changing costs throughout time.

Additional criticisms of the tenure system ensued from Haley (1985) noting that there was little incentive for tenure holders to invest back into the land base, particularly on volume-based licenses such as FLs, due to a lack of property rights. He also concluded that bureaucracy and political motivation often made government ineffective land managers, thus private property rights would need to be strengthened to achieve efficient forest management.

Concerned about the political ramifications of outright privatization yet recognizing the need to strengthen the incentives for silviculture and forest management, the BC government proposed "rolling over" FLs into area-based TFLs which conveyed stronger property rights. While a few new TFLs in the interior were created, this roll over policy was quickly deemed politically unfeasible as there was severe backlash from members of the public.

This public disdain seemed to come from prior provincial policy choices. Environmental groups, recalling the large clearcuts on coastal TFLs during the "sympathetic administration" days, rejected the notion that the forest should be managed like a crop, stressing the value of BC's unique ecosystems. First Nations residents claimed their title over the land and resources had not been ceded and that their aboriginal rights were being infringed by resource extraction. They called upon the government and tenure holders to consult them further with regard to land use activities and decisions. The general public also viewed the roll over proposal as another backroom deal between industry and government where valuable resources were given over to a restricted few in a less than transparent manner. Finally, continued productivity gains associated with industrial style logging operations and technically efficient conversion facilities created fewer and fewer jobs per cubic meter harvested (Nixon 1991) prompting labour groups to cry foul demanding that the forest sector become more value added.

In 1988, the SBFEP was expanded by taking away 5% of the AAC held by existing tenure holders. However, in an attempt to increase jobs via value added manufacturing much of the timber was awarded on the basis of a "bid proposal" which was judged according to a combination of revenue, employment and value added criteria. This

added volume did little to curb complaints from the value added sector, who continued to claim that their expansion was being thwarted by a lack of access to additional volume and appurtenance clauses which required logs to be processed through existing facilities geared for high output low valued commodity production. Yet another public forestry commission was called to address the future direction of forest policy in the province.

Seeking sustainability

In 1991, the Forest Resources Commission (FRC) chaired by Sandy Peel issued a series of reports and recommendations regarding forest policy in the province, these are summarized below:

- A multi-layered planning process should be created rising from the local to provincial level. Regional land use planning groups would be mandated to zone land into various management categories with defined targets for particular resource activities with the goal of allocating land to its "highest value use".
- A more transparent timber supply process with updated inventory data needs to be tabled.
- A single all encompassing code of forest practices should be developed.
- The continued roll over of volume based licenses into area based licenses ought to be instituted once land use planning is complete.
- The further consolidation of tenure rights should be negated and competitive log markets which allocate timber to their highest valued use should be established. To do this AAC should be progressively taken back from the hands of large integrated manufacturers such that no more than 50% of manufacturing capacity is held in AAC. This would free up volume to flow through log markets managed by a new government entity, and reallocate timber to first nations groups and small scale tenures.
- The administration of stumpage fees ought to be based on the newly established competitive markets.

A left-leaning New Democratic Party (NDP), largely supported by labour and environmental groups, came to power shortly after the FRC released its report. Not surprisingly the new government devoted much of its policy resources to addressing the environmental impacts of BC forest practices, all the while trying to maintain high employment in the forest sector. The government set out an aggressive plan to achieve the first three FRC recommendations listed above. Planning became ubiquitous as a multi-layered bureaucracy increased protected areas, established regional land use plans and developed a stringent prescriptive based Forest Practices Code (FPC). The focus on environmental issues was also greatly influenced by the environmental protests over the logging of old growth coastal watersheds which drew national and international attention, threatening to result in the boycott of BC wood products in some marketplaces.

Increased environmental restrictions and land use decisions resulted in significant reductions in AACs, particularly in areas which had high non-timber values such as the

coast and the Southern interior "wet belt". This reduction in cut levels threatened to result in significant job losses and would leave a portion of the forest industry overcapacity and hungry for wood. The reduction also meant that timber security was a premium, so any suggestion of implementing the FRC recommendation of taking away further volume for the creation of a competitive log market was met with severe disapproval from industry.

To curb the job losses and avoid political difficulties associated with strengthening tenure rights in order to induce silviculture investment, the government set out to create replacement jobs for unemployed loggers and sawmill workers in enhanced silviculture and value added activities. A new layer of bureaucracy was created in 1994 called Forest Renewal British Columbia (FRBC) to manage these activities. FRBC was to be funded by increased stumpage fees, not established by competitive markets as the FRC suggested, but instead by a modified CVP system that raised target rates for given levels of lumber values, particularly high ones (Cashore et al. 2001). These higher stumpage fees did little to curb American subsidy allegations however. As a result of lengthy negotiation, the dispute was settled in 1996 with a 5 year quota-tariff softwood lumber agreement (SLA). With quota being allocated based on past lumber shipments to the U.S., thus the coastal industry, which was largely focused on the Japanese market, received little.

Economic realities

While the environmental movement still asked for further improvements, the planning initiatives were relatively successful at quelling the concerns domestically and internationally over BC forest practices. In fact, a study conducted by Cashore and McDermott (2004) showed that BC's increased protected areas and a new FPC made it, in many ways, a global leader in environmentally friendly forest practices. Nonetheless, many of the planning initiatives would prove to be detrimental for the forest industry and dependent communities. In 1998, the provincial government announced a jobs and timber accord that promised the creation of over 20,000 new direct jobs from forestry activities through more silviculture activities funded by FRBC, the expansion of "bid proposals" and the introduction of a new Community Forest (CF) tenure. At first, these initiatives showed some fruit but there were growing signs that they could not be sustained.

FRBC was implemented at a time when lumber prices were at record levels, due to reductions in supply coming from U.S. national forest lands, along with heightened demand from a red hot North American and Japanese economy (dubbed the "great price spike" by Sohngen and Haynes 1994). These prices were thought to last forever and at the start the program was awash in revenues. Unfortunately, much of the initial funds were spent on administration and silviculture projects which were rarely justified from an economic perspective.

Economists naturally questioned whether these policy initiatives could be sustained. Binkley (1997_a, 1997_b) predicted that prices for old growth would hit a "choke price"

inducing cheaper substitute products from other parts of the world, causing remaining high cost stands to become "economic wilderness".[9] He proposed that BC needed to take a road "less travelled by". This would involve moving away from the traditional paradigm of SY where multiple-uses were managed over a land base with loosely defined property rights, to one where the land-base was increasingly specialized with timber zones managed intensively under a stronger property rights regime, which would in turn free up more areas to be managed exclusively for non-timber forest values.

An event study of the stumpage increase and subsequent creation of FRBC was conducted by Binkley and Zhang (1998). Their results indicated that no new capital was created by the policies, only transferred from private to public hands, concluding that the marketplace gave the BC government no credit for the investment activities associated with FRBC. Furthermore, van Kooten and Wang (1998) and Haley (1996) argued that the enormous costs of the FPC would significantly undermine the competitive position of the forest industry. It was not long before these warnings came to be realized.

Time for change?

Following the reduction in the value of tenure brought about by the stumpage fee increase and the collapse of the Japanese market, the coastal industry now became open to giving up tenure rights in order to establish a stumpage system based on competitive markets which would be more flexible and could be used to open up access to American markets.[10] Recognizing the changes in the marketplace and the costs of the FPC, the CVP system was adjusted downward in both the coast and interior regions in 1998. Unable to deliver on promises outlined in the jobs and timber accord, members within the NDP began questioning their "soviet style" of governance and became more open to privatization (Vancouver Sun 1999). As a result of the market down turn, FRBC revenues plunged and its size and scope was significantly reduced and the FPC was streamlined. Additionally, alternative timber pricing mechanisms began to be experimented with, as a Market Pricing System (MPS) was developed which used hedonic techniques to value timber based on bidding results in previous SBFEP auctions.

An MPS model was created for both the coast and interior regions and was used to set minimum acceptable bids (upset prices) on future auctions in the SBFEP. The coastal MPS model was then extended on a trial basis to price timber containing greater than 60 percent hemlock and balsam stemming from major tenure holders. This provided the coastal industry with some short term stumpage relief and set off a sequence of market-based timber policy developments.

9 Choke price is the price where quantity demanded reaches zero. In the case of old growth timber this demand is choked out by the availability of substitute products (second growth timber, engineered forest products, non-wood building materials etc.)

10 The largest coastal company at the time, MacMillan Bloedel, kick started this discussion in 1998 with the release of "A White Paper for Discussion: Stumpage and Tenure Reform in BC".

The Forestry Revitalization Plan

Partly as the result of the previous government's failure to uplift the rural economy via central planning, a free market oriented Liberal party overwhelmingly won the provincial election (77 out of 79 seats in the legislature) in May 2001. At about the same time, the SLA with the US expired, only to be replaced with steep countervailing duties. The softwood dispute with the US became a top priority with the new government resulting in significant discussion about potential policy changes that could eliminate the appearance of subsidies and put the softwood dispute to rest. Following a report issued by DOC undersecretary Grant Aldonas, which signalled that policy changes could form the basis of a long term agreement, the government announced the Forestry Revitalization Plan (FRP) (MoF 2003). The FRP entailed the following changes to forest policy in the province, each of which is discussed in further detail in the next chapter.

- The reallocation of 20% of the AAC away from major tenure holders to the SBFEP, small scale tenures (WLs and CFs) and First Nations.
- All new short-term (TSLs) and long-term tenures (FLs and TFLs) will be auctioned solely based on price. The auction results to be used to generate a new administered stumpage system.
- The elimination of cut control, timber processing and appurtenancy restrictions
- The increased freedom to transfer and subdivide tenure

The tenure reallocation was perhaps the central component of the plan; this was done to meet many objectives, all in a *quid pro quo* manner. Firstly, the major licensees in receiving greater flexibility and less regulatory burden had to give up tenure to increase the volume at auction which improved the sample size of the MPS model, reduced their market power, and made the system more saleable to American on lookers. Second, appurtenancy, mill closure regulations, cut control and bid proposals were viewed by the public as part of an informal "social contract". The elimination of these regulations would be viewed by some - whether rightly or wrongly - as a breach of contract, putting communities at risk in favour of relaxed regulations for large corporations. Allocating volume to small tenures such as woodlots and community forests, as well as increasing the volume available to independent loggers and small manufacturers at auction, made the policy changes more palatable to rural communities. Lastly, legislative provisions giving government the ability to directly allocate licenses and share revenue with First Nations was hoped to be an important bargaining chip in the ongoing treaty negotiation process.

The striking similarities of the plan to the Aldonas proposal showed that the softwood lumber dispute with the US was no doubt a key driver of the policy changes. This was a fact that was played down by provincial politicians to diffuse growing public sentiments that BC had lost its sovereignty over forest policy, allowing outsiders to dictate how things were done in the woods. Although, it could be argued that the dispute with the US provided the incentives and conditions for the government to revisit the long over-due agenda of reforms highlighted by the two previous royal commissions (Pearse

1976, Peel 1991). The combination of the pressure from US, the state of the coastal industry, and a market oriented government with an enormous majority, finally made the implementation of the reform agenda politically feasible.

That being said, the changes to tenure still failed to address one outstanding suggestion from the FRC report; the roll over of volume based tenures to area based tenures with lengthened durations. Calls for change in this area of forest policy have been repeated by others (Zhang & Pearse 1996). Nonetheless, an important hurdle came from court decisions upholding the existence of aboriginal rights and title to the land (*Delgamuuk'w v. BC*) and the need for government to consult extensively with first nations in the transfer of tenure (*Haida Nation v. B.C. and Weyerhaeuser).* Furthermore, lumping area-based tenure reform into the revitalization strategy could have jeopardized the entire suite of policies. Area-based tenures with longer durations (particularly in the hands of large companies) could fuel public concern that the forest was being increasingly privatized, a word that fuels many emotions in a society which deems public control of forests as part of their "national soul" (Hurtig 2002, Reed 2001). Indeed, a working forest initiative set in motion prior to the FRP which tried to strengthen the certainty of the timber harvesting land base for industry as a whole prompted public protests. The words of deputy minister of forests Doug Konkin reveals the limited appetite for additional policy reform, "people can only take so much change" (Konkin 2005).

Summary and thesis outlook

In reviewing the evolution of timber policy in the province one can see that exogenous factors (changing market conditions, global environmental demands, trade barriers etc.) which affected the scarcity level of the forest resource often shaped the development of institutions. However, it also seems that policy maker's responses to changing demands were constrained by prior choices and institutions. For example, past assignment of rights (formal and informal) to the benefit stream (timber and non-timber) flowing from the forest often meant that change, however necessary, could not be done easily. Some who hold, or claim to hold these rights could have vested interests in the status quo. As a consequence, some form of compensation is required (or demanded) when reforms take place and any change can be path dependent. Therefore, in concert, changing demands and history have served to produce the complex set of tenure arrangements and policies seen in the province today. The current tenure system and its origins are summarized in the Appendix.

The research in the rest of this thesis explores both aspects of change for an assortment of forest policies in the province. They highlight the underlying economic conditions which place pressure on existing arrangements and draw attention to the agents which were, or potentially could be, impacted by reform. The next chapter reveals some of the effects the FRP has had on the large industrial players in the province; this is followed by an assessment of BC's plan to rely increasingly on its timber market and the challenges that may come given the historical lack of competition within it; chapter 5 shows how

the distribution of timber rents has changed as aspects of the social contract have been eroded; and lastly chapter 6 uncovers the potential rents available from timberland in the province across a broad range of geographical conditions. These rents are used to assess exiting timber institutions and the potential demand for further change.

References

British Columbia Ministry of Forests, 2001. Canada – United States softwood lumber trade discussions: British Columbia proposed forest policy changes. Ministry of Forests Revenue Branch, Victoria.

British Columbia Ministry of Forests, 2003. Forest Revitalization policy change legislation overview. Ministry of Forests, Victoria.

Binkley, C.S., 1997_a. A cross road in the Forest: The path to a sustainable forest sector in British Columbia. BC Studies 113: 39-68.

Binkley, C.S., 1997_b. Preserving nature through intensive plantation forestry: The case for forestland allocation with illustrations from British Columbia. The Forestry Chronicle 73(5): 553-559.

Binkley, C.S., D. Zhang. 1998. Impact of timber-fee increases on British Columbia forest products companies: an economic and policy analysis. Canadian Journal of Forest Research 28:617-625

Byron, R.N. 1978. Community Stability and Forest Policy in British Columbia. Canadian Journal of Forest Research, 8 (1): 61-66.

Cashore, B., Hoberg, G., Howlett, M., Rayner, J., Wilson, J., 2001. In Search of Sustainability: British Columbia Forest Policy in the 1990s. UBC Press, Vancouver.

Cashore, B., C.L. McDermott. 2004. Global Environmental Forest Policy: Canada as a constant case comparison of select forest practice regulations. International Forest Resources, Victoria.

Drushka, Ken. 1999. In the Bight. Harbour Publishing. Madeira Park, BC.

Fulton, F.J., 1910. Royal commission of inquiry on timber and forestry. Ottawa.

Haley, D., 1980. A regional comparison of stumpage values in British Columbia and the United States Pacific Northwest. Forestry Chronicle 56: 225-250

Haley, D., 1985. The forest tenure system as a constraint on efficient timber management: problems and solutions. Canadian Public Policy 11(3): 315-20.

Haley, D., 1996. Paying the piper: the cost of the British Columbia Forest Practices Code. Forum. 3(5): 26-28.

Hurtig, M., 2003. The vanishing country: Is it too late to save Canada? McClennan and Stewart, Toronto.

Konkin, D., 2005. Interior Truck and Logger Magazine winter 05 p. 18.

Nautiyal, J., Love, D. 1971. Some economic implications of methods of charging stumpage. Forestry Chronicle 47: 25-28.

Nixon, R. 1991. Comparative data charts explain forest management policies. Forest Planning Canada 7: 32-45.

Pearse, P.H. 1974. Crown charges for early timber rights: First report of the task force on crown timber disposal. Queen's printer, Victoria.

Pearse, P.H. 1976. Timber rights and forest policy in British Columbia, Report of the royal commission on forest resources. Queen's Printer, Victoria.

Pearse, P.H. 2001. Ready for change: crisis and opportunity in the coast forest industry. A report to the Minister of Forests on British Columbia's coast forest industry. Vancouver.

Peel, S. 1991. The future of our forests, forest resources commission. Queen's Printer, Victoria.

Reed, L. 2001. Two centuries of softwood lumber war between Canada and the United States. Free Trade Lumber Council, Montreal.

Ross, W.R. 1912. British Columbia's forest policy: Speech by the Hon. William R. Ross, Minister of Lands on the second reading of The Forest Bill. King's Printer, Victoria.

Samuelson, P.A. Forestry in an evolving society. Economic Inquiry 14(4): 466-92.

Scott, A. 1976. The cost of compulsory log trading. In Timber policy issues in British Columbia, eds. William McKillop and Walter J. Mead. UBC Press, Vancouver.

Sloan, G. 1945. Report of the Honourable Gordon McG. Sloan, Chief Justice of British Columbia relating to the Forest Resources of British Columbia. Banfield King's Printer, Victoria.

Sloan, G. 1957. Report of the Honourable Gordon McG. Sloan, Chief Justice of British Columbia relating to the Forest Resources of British Columbia. Queens Printer, Victoria.

Sohngen, B.L., R.W. Haynes. 1994. The great price spike of 93: an analysis of lumber and stumpage prices in the Pacific Northwest. Res. Pap. PNW-RP-476. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Uhler, R.S. 1991. The great subsidy debate. In Canada United States trade in forest products. Edited by R.S. Uhler. UBC Press, Vancouver, Canada.

Vancouver Sun. 1999. Privatize BC's forest lands, Miller says in a call for overhaul. 10 April. Vancouver Sun, Vancouver.

United States. Department of Commerce. 2003. Proposed Analytical Framework Softwood Lumber from Canada: Discussion Draft. Washington, DC: US Department of Commerce.

van Kooten, G.C., Wang, S., 1998. Estimating economic costs of nature protection: British Columbia's forest regulations. Canadian Public Policy 24(s2): 63-71.

Vincent, J.R., 1990. Rent capture and the feasibility of tropical forest management. Land Economics 66(2): 213-223.

Zhang, D., Pearse P.H., 1996. Differences in silvicultural investment under various types of forest tenure in British Columbia. Forest Science 42: 1-8

List of abbreviations used in chapter 2:

AAC	Annual Allowable Cut
ACE	Allowable Cut Effect
CVD	Countervailing Duties
CVP	Comparative Value Pricing (administered stumpage system)
DOC	Department of Commerce
FL	Forest License
FML	Forest Management License
FPC	Forest Practices Code
FRBC	Forest Renewal British Columbia
MAI	Mean Annual Increment
MPS	Market Pricing System
PA	Pulpwood Agreement
PSYU	Public Sustained Yield Unit
SBFEP	Small Business Forest Enterprise Program
SLA	Softwood Lumber Agreement
SY	Sustained Yield
TFL	Tree Farm License
TL	Timber License
TSA	Timber Supply Area
TSHL	Timber Sale Harvesting License
TSL	Timber Sale License
WL	Woodlot License

Appendix. Summary of current tenure arrangement in British Columbia

Tenure	Duration	Structure and Size	Management Responsibilities	Fees	Origins
Tree Farm License (TFL)	25 years (evergreen)	area - based (typically exceeding 100,000 ha in size)	Timber supply analysis and management planning according to SY principles. Monitoring forest health and forest inventory. Pre-harvest operational planning and reforestation following harvesting. Until recently timber processing requirement.	Administered Stumpage fee at the time of harvest (allowances for management responsibilities)	"private working circle" developed after the 1st Sloan Commission. Began as a FML with a perpetual term.
Forest License (FL)	Up to 20 years (evergreen) although non-replaceable forest licenses (NRFLs) can also be issued.	volume-based quota (AAC) in TSA	Pre-harvest operational planning and reforestation following harvesting. Until recently timber processing requirement.	Administered Stumpage fee at the time of harvest (allowances for management responsibilities)	Converted from TSHL following Pearse Commission. Operations are within a TSA also known as the "public working circle" which was originally termed PSYU following the Sloan Commission.
Timber Sale License (TSL)	Up to 4 years (typically 1 year)	area - based (typically 10 to 100 ha in size)	None, however in the past award was based on employment and manufacturing conditions (i.e. bid proposal)	Stumpage fee determined by auction bid	Began to be auctioned by the Forest Service following the Fulton Commission. Fell out of favour after the Sloan Commission, increased in number after the SBFEP to be allocated more volume after the FRP.
Timber License (TL)	Variable (renewed until mature timber is harvested)	area-based (variable in size)	Pre-harvest operational planning and reforestation following harvesting.	Royalty rate and annual rental fee.	Award ceased following the Fulton Commission.
Woodlot License (WL)	Up to 20 years (evergreen)	area-based (up to 600 ha in size)	Timber supply analysis and management planning according to SY principles. Monitoring forest health and forest inventory. Pre-harvest operational planning and reforestation following harvesting.	Administered Stumpage fee at the time of harvest (allowances for management responsibilities)	Put in place following advice of Pearse (1976)
Community Forest (CF)	5 year pilot program and then 25 - 99 years	area-based (20,000 ha on average)	Timber supply analysis and management planning according to SY principles. Monitoring forest health and forest inventory. Pre-harvest operational planning and reforestation following harvesting.	Administered Stumpage fee at the time of harvest (allowances for management responsibilities)	Pilot program developed in 1998. Institute full program with additional areas following the FRP.

III. Revitalized? An event study of forest policy reform in British Columbia

This chapter is from Niquidet, K. 2007. Revitalized? An event study of forest policy reform in British Columbia. Revise and resubmit Journal of Forest Economics.

Abstract

In response to the restricted market access and declining global competitiveness facing its domestic forest industry, the British Columbian government has embarked on an ambitious plan of policy reform termed the Forestry Revitalization Plan (FRP). Regulations governing the structure of the industry have been relaxed and administered stumpage systems have been made more market based. Using daily returns data on thirteen publicly traded forest companies that operate in the province, the impact of the FRP was analyzed using event study techniques. Results show that the announcement of the FRP generated significant negative abnormal returns for several firms. These results may be explained by the new stumpage system and the loss of forest tenure. Over the longer term the benefit of the regulatory change will depend on its ability to open up access to U.S. markets and how the industry structures itself in face of increased market pressures.

Introduction

Forestry has traditionally been the staple of the economy in British Columbia (BC), particularly in rural areas. This reliance on forestry coupled with the fact that over 95% of the forest land is owned by the public has often made forest policy the focal point of provincial politics. This was particularly evident of late as the forest sector began the new millennium facing a host of challenges.

Increased protected areas and a new forest practices code in many ways made BC a leader in environmentally friendly forest practices (Cashore and McDermott 2004) but it also substantially increased the cost of extracting and processing timber (van Kooten and Wang 1998, Haley 1996). This was particularly critical for the coastal industry as the traditional marketplace for its products (Japan) was also shrinking due to increased competition from Europe and questions over the structural properties of its primary species, western hemlock (*Tsuga heterophylla)*. Unable to switch into U.S. markets because of the quota-based softwood lumber agreement (SLA), and uncompetitive operating costs, several coastal sawmills shut down or ran at levels which were unable to recover the cost of capital.[1] Little investment was being made in new working capital and many

1 Quota was allocated on the basis of historical shipments. The Coast being historically oriented towards Japan consequently received little.

of the rural communities that depended on the forest sector began to decline.

Taking advantage of quota rents (van Kooten 2002), superior milling technology and lower cost logging, the interior industry was not nearly as distressed as their coastal counterparts. Nonetheless, with the expiration of the SLA on March 31st 2001 and the subsequent imposition of a 19.67 percent preliminary countervailing duty on Canadian lumber imports by the U.S. Department of Commerce (DOC) on August 10th 2001, fears of industry decline also swept through the interior.

Later in 2001, forest economist Peter Pearse was called upon to review the state of the coastal forest industry. His report documented an industry "in crisis", operating at the margin as the highest cost lumber producer in the world and subject to fierce global competition and rapidly changing product markets. Pearse (2001) recommended that many of the regulatory restrictions governing the industry be relaxed to allow for more flexibility and that the softwood lumber dispute with the U.S. be urgently dealt with.

At about the same time Pearse was drafting his report, the BC Ministry of Forests (MoF) (2001) began to circulate proposed forest policy changes for softwood lumber trade discussions. The proposal entailed increasing the amount of timber sold by competitive auctions, a stumpage system based on auction results, the removal of appurtanancy and processing requirements, the elimination of cut control and utilization policies that may encourage the removal of uneconomic timber, and the freedom to subdivide and transfer tenure.

In early 2003 a draft framework authored by DOC undersecretary Grant Aldonas (hereafter the Aldonas proposal) which outlined how provinces could receive "changed circumstance" and be relieved of duties was released. This document gave hope that policy reforms could lead to a softwood lumber solution. Responding to the Aldonas proposal the BC government announced on March 26, 2003 the Forestry Revitalization Plan (FRP) (MoF 2003). The FRP can be loosely divided into four main parts, all connected to some degree.

1. *Tenure re-allocation* – Major licensees, defined as those who have greater than 200,000 m^3 of replaceable annual allowable cut (AAC), will have 20% of their volume taken away, subject to fair compensation. A portion of this volume (approximately 50%) will be re-allocated to small scale tenures (woodlots, community forests and first nations) and the other half is to be auctioned to the highest bidder via the BC Timber Sales program (BCTS), formerly known as the Small Business Forest Enterprise Program (SBFEP).
2. *Timber auctions* – BCTS will eliminate the SBFEP practice of bid proposals - where timber was allocated on the basis of value-added and employment criteria - awarding timber solely on the basis of price.[2] The increased volume of timber auctioned through BCTS (approximately 20% of the total AAC) to be used to set administered prices on timber derived from long term volume based (Forest Licenses) and area based (Tree Farm Licenses) tenures. With the new administered stumpage system

2 Although for a short time (i.e. program to be phased out) bidding for some sales will be restricted to small primary manufacturers and value added manufacturers termed category 2 bidders.

being termed the Market Pricing System (MPS). In addition, any new long term tenures will be auctioned.

3. *Cut control and processing regulations* - Appurtenancy and timber processing clauses which tied volumes from tenures to specific manufacturing facilities are to be eliminated, allowing logs to flow to their highest valued use. Companies will also no longer be penalized for closing mills and when harvesting will not be required to remove all "merchantable" timber but have the option of leaving the timber standing or on the ground, subject to a stumpage fee and subject to silviculture objectives (this policy has been dubbed "take or pay").[3] Cut control regulations which restricted harvesting to be within 50 to 150 percent of the AAC each year and plus or minus 10 percent over a five year period are now eliminated. However, a maximum harvest level over a five year period will still be retained for sustainability purposes.
4. *Tenure Transfers and Subdivisions* – Tenures can now be transferred without penalty (formerly all transfers subject to 5% loss of AAC) and no longer need consent from the Minister of Forests, just notification. With the only basis for holding up transfers being concerns over the effect the transfer may have on competition in the log market. Tenure holders will also be free to subdivide their tenures, as forest management concerns are the only basis for refusal.

As can be seen above, the FRP clearly decentralizes the regulatory regime governing the forest sector. The government would now have little say in determining where and how timber should be used and how the industry should be structured. The plan was also very similar to the MoF proposal for softwood lumber negotiations, the key difference being the reallocation of timber tenure away from major licensees.

The potential impacts of the FRP are numerous; this study does not pretend to capture all of the effects of the regulatory change but instead will focus on one of its key goals, namely the increased health of the forest industry. To assess the change in industry health, I do not rely on my own normative criteria but instead take a revealed preference approach, allowing the assessment of investors to be communicated via their actions on public security exchanges. To do so I employ event study methods on the daily returns of publicly traded forestry companies that operate in BC.

The outline of the rest of this article is as follows. The next section summarizes the event study methodology chosen. This is followed by a description of the data and the companies involved in the study. The results of the event study are then presented in the subsequent section. These results and their potential policy implications are then discussed. The last section concludes.

Event Study Methodology

Event studies have widely been used by financial economists to study regulatory

3 The definition of a merchantable log varies according to species and contains measures of log quality. Loosely speaking however it is all logs with a top diameter greater than 10cm.

change, mergers and acquisitions, and earnings announcements. MacKinlay (1997) and Binder (1998) offer comprehensive overviews of the subject. This study employs standard "market model" asset pricing methodology which assumes the return of any given security is linearly related to the return of the market portfolio.[4] This process of return generation is more formally shown to be:

$$(1)\quad R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

where R_{it} is the return to security i on day t, R_{mt} is the return to the market index on day t, α, is a firm specific intercept term, β_i is a regression parameter that reflects the systematic risk of security i and ε_{it} is a random disturbance term that is assumed to be normally distributed with mean zero. Firms with β_i greater than 1 represent high risk firms relative to the broader market, and firms with β_i less than 1 thought of as being lower risk.

The primary endeavour of event studies is to investigate whether abnormal returns were generated as the result of some announcement or intervention (event). It is assumed that markets are efficient and the anticipated effects of an event on a firm's future profitability are capitalized into its security price quickly, generating an abnormal return. Traditionally, estimating abnormal returns from a market model associated with an event has been done in two ways. First is a deviations approach which estimates equation (1) and uses this model to predict the normal return during the timeframe of the event (known as the "event window"), the difference between the actual and predicted returns being the abnormal return attributed to the event in question. A more straightforward approach however is to estimate the abnormal return for each event (γ_i) in one step during the regression by the use of a dummy variable (D_t) which takes the value of 1 during the "event window" and 0 otherwise.

The choice of an event window is a central step in the design of an event study. McWilliams and Siegel (1997) criticize the common practice of using long event windows, which in some cases were up to 181 trading days. Long event windows have been shown to severely reduce the power of testing (Brown and Warner 1985) and tend to increase the likelihood of including confounding effects. Further, empirical studies have shown that the market tends to react to new information quite rapidly. For example Mitchell and Netter (1989) found that the market responded to changes in federal tax legislation within 90 minutes. As a consequence, the shortest possible window using daily data was initially chosen as the default event window (i.e. the announcement day).

That being said, I was also aware that in some cases - particularly in instances of regulatory change where the government is consulting with industry - information may be leaked or the regulatory change is anticipated by the market prior to the announcement (Schipper and Thompson 1985). Furthermore, given the scope and potential ambiguity associated with the regulatory change, it may take the market some additional time

4 Other formulations include the Capital Asset Pricing Model (CAPM) and a multi-factor model based on the Arbitrage Pricing Theory (APT). Mackinlay (1997) in his review of event-study methodology points out that the CAPM imposes questionable restrictions and that a more complex APT model often provides little gain to the simpler market model.

to assess what the changes will mean for each firm. Indeed, Rucker et al. (2005) demonstrate that the type of information released impacts the speed and shape in which events are absorbed into prices. They develop and employ a generalized event study method which allows the market response to take different functional forms, showing that the traditional dummy variable method outlined above is akin to their uniform event response model (UERM) where the effect of the event is constant throughout the event window. The key difference between the two models is that unlike the dummy variable approach where the width of the event window is imposed on the model, the UERM endogenizes this decision. This study keeps with the traditional dummy variable approach, but to be consistent with the UERM, several regressions with varying window widths and locations will be run, with the window that minimizes the sum of squared errors chosen as the proper window.

The period after the event is also of interest as the FRP may have led to a structural change in the return generating process, causing firms to be viewed upon with more or less risk. To investigate this I employ a structural break test by creating another dummy variable (Z_t) that equals 1 for the period after the event window and zero otherwise. This model is shown below as:

$$(2) \quad R_{it} = \alpha_i + \beta_{1i} R_{mt} + \gamma_i D_t + \psi_i R_{mt} Z_t + \varepsilon_{it}$$

The regression parameter ψ represents the difference between the risk parameter in the post FRP time period (β_2) and that in the pre FRP time period (β_1). A positive ψ therefore indicates that risk has gone up after the event and the hypothesis $\beta_2 = \beta_1$ is equivalent to $\psi = 0$. The change in risk is of interest because it indicates the effect the FRP has had on the long term expected returns of a company. If risk levels for a firm go up, the market will demand a risk premium and the firm's cost of capital will increase. In consequence, the structural break test provides a preliminary signal as to how future investment may have been influenced by the policy changes.

A priori, it is expected that because of firm specific characteristics, risk levels (β) will differ across firms and each firm could be impacted by the FRP in a substantially different way. For this reason a panel data approach was not taken. To accommodate these expectations, equation 2 can be estimated for each of the *i* firms individually using ordinary least squares. This approach however assumes that there are no contemporaneous correlations between the error terms of each firm; an assumption that is generally not valid in instances of regulatory change – such as the FRP - where there can be impacts on all firms in a given instance in time (Binder 1998). To overcome this correlation, the model is typically treated as a system of equations and estimated via Seemingly-Unrelated-Regression (SUR) (Zellner 1962).

A final estimation issue to be aware of is serial correlation. In his critique of event study methodology, Salinger (1992) points out that event studies frequently ignore serial correlation in the error term. If serial correlation is shown to exist, an AR(1) disturbance process can also be adopted into the SUR framework by transforming the data by either Prais-Winsten or Cochrane-Orcutt techniques (Greene 2000 p. 634-635).

Data

The daily return index (*RI)* for 13 publicly traded forest companies which operated in varying degrees within British Columbia was recovered from Datastream Advance 3.5 for the period June 24, 2002 to April 1, 2004 (448 trading days). These firms are: Weyerhaueuser (Weyerhaeuser), West Fraser Timber Co. Limited (West Fraser), Slocan Forest Products Limited (Slocan), International Forest Products Limited (Interfor), Riverside Forest Products Limited (Riverside), Canfor Corporation (Canfor), Doman Forest Products Limited (Doman), TimberWest Forest Corp. (Timberwest), Ainsworth Lumber Company Limited (Ainsworth), Tembec Inc. (Tembec), Abitibi Consolidated Inc.(Abitibi), Pope & Talbot and Norske Canada (Norske)[5].

For the same period, the *RI* of the S&P TSX composite index was recovered to be used as the market index. Returns for each firm and the market index were then derived in the following manner:

$$(3) \quad R_t = \frac{RI_t}{RI_{t-1}} - 1$$

Changes in the *RI* were used instead of changes in the security price (*P*) as they depict the total return associated with holding the security more accurately, taking both capital gains (changes in *P*) as well as dividend payments into account.[6]

Table 1. Manufacturing Capacity and Tenure Holdings in British Columbia

	Allowable Cut (m^3/year)	Annual Lumber Capacity (millions of board feet)	Pulp Capacity (000's of metric tonnes)	Panel Capacity (million sq. ft, 3/8" basis)
Weyerhaeuser	6,886,642	1,179 (17%)	466 (16%)	-
West Fraser	5,139,521	1,712 (73%)	780 (79%)	148 (31%)
Timberwest	1,319,595	132 (100%)	-	-
Tembec	1,579,789	319 (21%)	393 (22%)	-
Slocan	4,345,121	1,484 (100%)	221 (100%)	684 (100%)
Riverside	2,491,812	544 (100%)	-	483 (100%)
Norske	-	-	1,406 (100%)	-
Interfor	3,099,358	1,017 (100%)	-	-
Doman	3,778,686	951 (100%)	439 (100%)	-
Canfor	8,305,465	2,502 (85%)	1,550 (100%)	127 (100%)
Ainsworth	623,534	-	-	430 (33%)
Abitibi	932,500	330 (17%)	162 (3%)	-
Pope & Talbot	1,205,417	560 (80%)	644 (76%)	-

5 Norske Canada has since been renamed Catalyst Paper.

6 $RI_t = R_{t-1}\frac{P_t}{P_{t-1}}$ except when t = ex-date of the dividend payment then: $RI_t = RI_{t-1}\frac{P_t + D_t}{P_{t-1}}$

If the FRP was to have an impact on the above firms, one might expect that the effect could depend on the type of assets the firm holds in the province as well as to what degree its BC operations are important in its overall business. Using MoF data based on the year 2002, table 1 reports some descriptive statistics for each of the firm's BC holdings. Using information from each of the company's annual reports, I was also able to derive some measure of how important this BC capacity is to the company's overall operation; this fraction is reported in brackets within the table. Given that the holdings for the firms Weyerhaeuser, Tembec, Abitibi, and Ainsworth are primarily located outside of BC my prior expectation was that if the FRP was to have an impact (negative or positive) it would be lessened for these firms due to their diversification. Furthermore, seeing that the regulatory change pertained to crown (public) lands only, I had similar feelings about the firm Timberwest, as this firm predominately operates on private land, with timber production from its crown holdings making up approximately one third of its annual harvest.

Results

After starting with an event window which included the day of the announcement only, the event window was slowly expanded. These expansions did not prove to reduce the sum of squared errors of the regression, with the exception of two firms: Abitibi and Norske. For these firms, including the day of the announcement as well as the following trading day improved model statistics. The results associated with this formulation are listed in table 2.

Table 2. Event Study Results

Equation	β_1	ψ	γ	α	R^2	F-stat	Durbin Watson
Weyerhaeuser	1.218***	-0.203	0.003	-0.0005	0.239	46.8***	2.361
West Fraser	0.452***	-0.329*	-0.026*	0.0004	0.042	6.58***	2.183
Canfor	0.812***	0.245	-0.0002	0.0002	0.106	17.61***	1.968
Riverside	0.202	0.124	-0.046***	0.0012	0.018	2.84***	2.089
Slocan	0.483***	-0.054	-0.029	0.0019	0.023	3.55***	1.991
Tembec	0.737***	0.016	-0.018	-0.0008	0.080	13.11***	1.648
Interfor	0.867***	-0.625**	-0.048**	0.0014	0.055	8.72***	2.158
Pope & Talbot	1.425***	-0.129	-0.040	0.0002	0.125	21.54***	2.204
Ainsworth	0.189	0.265	-0.004	0.0049	0.003	0.480	1.966
Abitibi	1.365***	-0.214	-0.021*	-0.0010	0.271	55.35***	2.013
Timberwest	0.024	0.223*	0.008	0.0001	0.010	1.500	1.964
Norske	0.973***	0.500**	-0.037***	-0.0014	0.145	25.56***	2.161
Doman	0.559	0.990	-0.228**	0.0068	0.012	1.750	1.990

Note: *, significant at 15% level; **, significant at 10% level; ***, significant at 5% level

Breusch-Pagan test of independence: χ^2 (78) = 431.73, Pr = 0.0000

The market model had significant explanatory power for 10 of the 13 firms in question. The Breusch-Pagan test indicates that the contemporaneous correlation between the error terms of each equation is highly significant. Therefore, the SUR method significantly improves the efficiency of the model. The Durbin Watson statistic for each equation suggests that serial correlation is not a concern, making Prais-Winsten or Cochrane-Orcutt transformations unnecessary.

The announcement of the FRP appears to have brought about significant negative abnormal returns for several of the firms. These firms are West Fraser, Riverside, Interfor, Abitibi, Norske and Doman. With the exception of Abitibi, all of these firms are heavily based in BC, operating almost exclusively from fibre derived from public land. In fact, γ is negative for all firms whose main source of operations are in BC, except for Timberwest, which as mentioned earlier may be attributed to their holdings of private forestland.

A significant change in systematic risk also occurred for four of the firms; returns for the companies Norske and Timberwest reacting more to movements in the broader market since the FRP and the firms West Fraser and Interfor becoming less sensitive to market movements since the regulatory change.

Discussion

Negative Impacts

So what was it about the FRP that it was viewed so negatively by the market? Perhaps some of the industry dialogue on the announcement day will help answer this question. Some industry sources were quoted as saying the 20% figure was a "big number" (Central Interior Logging Association 2003) and another industry representative expressed concern about lost tenure, stating "with respect to the taking away of timber assets and cutting rights, we need much more information about how our members will be compensated" (Council of Forest Industries 2003). It therefore appears that the taking of tenure, and the subsequent compensation for this taking, was foremost on the minds of industry and presumably the market at the time of the announcement.

The issue of compensation for tenure has historically been controversial in British Columbia as past resource takings proved to be complex. Schwindt and Globerman (1996) explain that a lack of market transactions and the possibility that the market values of forest tenures reflect uncollected resource rents which are rightfully owned by the crown, make finding appropriate compensation values difficult. While the FRP stated that firms would be fairly compensated, there could have been a large divide between the marketplace and the government on the definition of "fair". Indeed, included in the FRP was a predetermined cap on the funds available for compensation, this could have been seen as being insufficient.

In spite of the possibility that tenure values reflect uncollected rents, unquestionably integrated forest companies also value tenure for the stable, secure, supplies that they provide. As discussed by Globerman & Schwindt (1986) and Yin et al. (2000) forest

product manufacturing facilities, having little value in alternate uses, can be considered specific assets, requiring very large sunk costs and once located are virtually immobile. Once investment is made in these assets, returns over and above that required to keep them operating in their specific use in the short run (quasi-rents) are generated which potentially can be appropriated by opportunistic suppliers. This causes firms to move away from anonymous spot markets and vertically integrate or enter into long term contractual relationships (Klein et al. 1978, Joscow 1988). The reallocation of tenure away from major integrated firms will diminish their control and security over supply. It is now necessary to source increased amounts of fibre derived from short term tenures auctioned by BCTS or from small independent tenure holders who as a result of relaxed cut control rules could not be guaranteed to harvest stable even flows of timber per annum. The reduced supply security and stability therefore could have contributed to the negative abnormal returns observed above.

The new stumpage system could have also played a role. Binkley and Zhang (1998) show that stumpage increases in 1994 significantly reduced security prices for BC forestry firms in direct proportion to the amount of tenure they held. While the specifics of the new market pricing system was not unveiled in the FRP, a similar process may have occurred as there could have been an expectation that fees derived from stumpage auctions would be higher than previous pricing formula. Unlike the stumpage change in 1994, which effectively increased stumpage across the board for all timber, movement to market based stumpage would probably have varying impacts depending on the species, location and quality of timber in question.

But what about the firm Norske? Table 1 reveals that it had no tenure and hence it would not be subject to the stumpage changes nor should its supplies be impacted, yet it was one of the most significantly impacted firms. Although Norske did not hold tenure directly, being a large coastal pulp producer it did have supply agreements with the major coastal tenure holders and these agreements were probably impacted by the FRP. The supply agreements were often tied to the amount of AAC held by the major tenure holders. Due to tenure being taken away, less volume would be party to these long term agreements and more fibre would have to be sourced from spot markets.

Norske's supplies, as well as the rest of the industry, will probably be impacted by the new utilization policy as well. One study of a coastal timber stand showed that harvesting to the government's merchantability standard reduced the return on the stand from about $2000/ha to a loss of $1200/ha (Uhler and Morrison 1986). Under the new take or pay policy one can expect that utilization decisions will be based on the proper economic margins (Paarsch 1993).[7] This significantly improves efficiency with the government cashing in on the increased rents made available. However, in cases where the marginal cost of extraction is high - as coastal logging typically is – this will probably mean substantial decreases in the supply of lower quality logs. A recent article (Larose, 2005) tends to support this hypothesis, describing a crisis in the market for pulp

7 Although, Paarsch shows that if loggers anticipate that they will not be charged for the material they leave behind they may utilize less logs than the efficient level.

logs on the coast as extraction costs make the harvesting of pulp logs uneconomic. The indirect impacts on Norske's supplies may explain why reaction to the announcement for this firm was somewhat prolonged (recall it had a longer event window).

Potential Positive Impacts

One could expect the FRP was not all bad news either. The improved flexibility it provides firms in structuring their operations was probably welcomed by the marketplace. Such benefits may be showing up in the significantly reduced risk levels associated with the firms West Fraser and Interfor. While being negatively impacted by the FRP for the reasons mentioned above, over the longer term perhaps the market sees these firms emerging from restructuring being more resilient to fluctuations in the global marketplace. In fact, several mergers and acquisitions have occurred in BC of late. Whether these transactions and the synergies that they bring can be attributed to the FRP is open to debate.

Some of the reforms that can be expected to improve the industry's performance could have already been 'priced in' by financial markets prior to the announcement as well. This stems from the signals put in place by the MoF softwood lumber discussion paper which was widely circulated (recall it mirrored the FRP with the exception of the tenure reallocation), and the fact that mill closure and timber processing regulations were not strictly enforced for quite some time prior to the announcement.

Seeing that the policy changes were, in whole or in part, designed to open up market access to the U.S., perhaps the greatest potential benefit of the FRP for the industry is the effect it may have on the softwood lumber trade between the province and the U.S. Certainly, the changes address a good portion of the Aldonas proposal; the elimination of processing requirements, a stumpage system based on timber auctions, the removal of exit barriers and economically consistent utilization standards. Nonetheless, they failed to win unfettered access to the U.S., as a recent agreement was put in place which aims to limit Canadian market share.

On the one hand, this seems to reinforce Canadian sentiments that policy reforms that did not have the effect of capping or reducing Canadian market share would fail to appease U.S. lumber lobbyists who appear to exert their will on U.S. administrations. Nordhaus (1992) has shown that stumpage fees, whether administered or market determined, will have no impact on the harvest levels in Canada which are set under a sustained yield (SY) paradigm.[8] As described earlier, the take or pay policy could reduce harvest volume at the intensive margin.[9] Nonetheless, it is not likely to have much of an effect on sawlog production in the interior where extraction costs are lower and the vast majority of softwood lumber production destined to the U.S. originates. Also, the Uhler and Morrison study suggests that reductions at the intensive margin could be offset by

8 Except in the case of an excessive fee

9 Here I use the term intensive margin in the traditional forestry sense being the point at the stand level the marginal revenue of extracting logs equals its marginal cost. This definition differs from that used in a land use sense where the intensive margin refers to the point where the rent of land is equal to zero if the opportunity cost of alternative land use is considered. See van Kooten and Folmer (2004 p. 41) for further details.

the fact that more stands are now economically viable, that is the extensive margin could expand.

On the other hand, it could be argued that outstanding issues still remain. Sedjo (2006) questions how timber supply set in a top down manner by the province (i.e. SY) compares to that of a market. Niquidet and van Kooten (2006) show that lower competition levels in northern BC reduce bids for stumpage, potentially tainting administered prices based on transaction evidence. Finally, log export restrictions, which traditionally have been at the heart of the dispute along with administered stumpage systems, still remain in place.[10] These issues are likely to be at the center of future negotiations and probably will need to be addressed in one form or another before unfettered access to the U.S. is given.

Conclusion

This paper outlined and analyzed some aspects of what has arguably been the most substantial change in Canadian forest policy in over fifty years. As shown by event study methods, the reaction conveyed by the market suggests that these policy reforms were, over the near term, detrimental to the existing industry's health. Perhaps this explains why such reforms, while being recommended in varying degrees by prior royal commissions (Pearse 1976, Peel 1991), have taken so long to be implemented. It may also explain why other provinces have been hesitant about implementing similar reforms. Over the longer term, the emergence of a revitalized industry in BC will depend on the industry's own ability to adapt to increased market pressures and on how successful the above and other market based policy reforms are at gaining free right of entry to its largest marketplace.

10 Although a recent report suggests that the province may be prepared to bargain on this issue provided access to lumber markets is provided (Dumont and Wright 2006).

References

Binder, J.J., 1998. The event study methodology since 1969. Review of Quantitative Finance and Accounting 11(2): 111-37.

Binkley, C.S., D. Zhang. 1998. Impact of timber-fee increases on British Columbia forest products companies: an economic and policy analysis. Canadian Journal of Forest Research 28: 617-625

British Columbia Ministry of Forests, 2001. Canada – United States softwood lumber trade discussions: British Columbia proposed forest policy changes. Ministry of Forests Revenue Branch, Victoria.

British Columbia Ministry of Forests, 2003. The Forestry Revitalization Plan. Ministry of Forests, Victoria. (http://www.for.gov.bc.ca/mof/plan/frp/)

Brown, S.J., J.B. Warner. 1985. Using daily stock returns: the case of event studies. Journal of financial economics. 14: 3-31.

Cashore, B., C.L. McDermott. 2004. Global Environmental Forest Policy: Canada as a constant case comparison of select forest practice regulations. International Forest Resources, Victoria.

Central Interior Logging Association. 2003. Policy: Reaction Varied. FactsFax issue #220. (http://www.cila.bc.ca/fax/fax220.pdf)

Council of Forest Industries. 2003. COFI will work with government to ensure competitiveness, revitalization. News release dated March 26th, 2003. (http://www.cofi.org/whatsnew/pressreleases/2003mar25.htm)

Dumont B. and D. Wright. 2006. Generating more wealth from British Columbia's timber: a review of British Columbia's log export policies. A report prepared for the British Columbia Minister of Forest and Range. (www.for.gov.bc.ca/het/Export35.pdf)

Haley, D., 1996. Paying the piper: the cost of the British Columbia Forest Practices Code. Forum. 3(5): 26-28.

Globerman, S., R. Schwindt. 1986. The organization of vertically related transactions in the Canadian forest products industries. Journal of economic behaviour and organization 7: 199-212.

Greene, W.H. 2000. Econometric Analysis: 4th Edition. Prentice-Hall Inc., New Jersey.

Joscow, P.L. 1988. Asset specificity and the structure of vertical relationships: empirical evidence. Journal of law, economics and organization 4: 95-117.

Klein, B., R.A. Crawford, A.A. Alchian. 1978. Vertical integration, appropriable rents and the competitive contracting process. Journal of law and economics 43:105-141.

Larose, A., 2005. Chip crisis. Truck Logger. 28(2): 23-25.

Mackinlay, A.C., 1997. Event studies in economics and finance. Journal of economic literature 35: 13-39.

McWilliams, A., Siegel, D. 1997. Event studies in management research: theoretical and empirical issues. The academic of management journal 40(3): 626-657.

Mitchell, M., Netter, J.M. 1989. Triggering the 1987 stock market crash: Antitakeover provisions in the proposed house ways and means committee tax bill. Journal of Financial Economics. 24: 37-49.

Niquidet, K., and G.C. van Kooten. 2006. Transaction evidence appraisal: competition in British Columbia's stumpage markets. Forest Science 52: 451-459.

Nordhaus, W.D., 1992. The impact of stumpage charges on prices and trade flows in forest products, appendix A to memorandum concerning alleged subsidies and preferentiality in the matter of certain softwood lumber products from Canada, INV. C-122-816. US Department of Commerce, Washington DC.

Paarsch, H.J., 1993. The effect of stumpage rates on timber recovery. Canadian journal of economics 26(1): 107-120.

Pearse, P.H., 1976. Timber rights and forest policy in British Columbia, Report of the royal commission on forest resources. Queen's Printer, Victoria.

Pearse, P.H., 2001. Ready for change: crisis and opportunity in the coast forest industry. A report to the Minister of Forests on British Columbia's coast forest industry. Vancouver.

Peel, S., 1991. The future of our forests, forest resources commission. Queen's Printer, Victoria.

Rucker, R.R., Thurman, W.N., Yoder, J.K. 2005. Estimating the structure of market reaction to news: information events and lumber futures prices. American Journal of Agricultural Economics. 87(2): 482-500.

Salinger, M. 1992. Standard errors in event studies. Journal of Financial and Quantitative Analysis 22: 467-482.

Schipper, K., Thompson, R. 1985. The impact of merger-related regulations using exact distributions of test statistics. Journal of Accounting Research 23(1): 408-415.

Scwindt, R., Globerman, S., 1996. Takings of private rights to public natural resources: a policy analysis. Canadian public policy 22(6): 205-224.

Sedjo, R., 2006. Comparative views of different stumpage pricing systems: Canada and the United States. Forest Science 52(4): 446-450.

Uhler, R.S., P.D. Morrison. 1986. Utilization standards and economics efficiency in British Columbia forests. Forest Economics and Policy Analysis Project. Report 86-1. University of British Columbia, Vancouver.

van Kooten, G.C., 2002. Economic analysis of the Canada-United States softwood lumber dispute: playing the quota game. Forest Science 48: 712-721.

van Kooten, G.C., Wang, S., 1998. Estimating economic costs of nature protection: British Columbia's forest regulations. Canadian Public Policy 24(s2): 63-71.

Yin, R., T.G. Harris, B. Izlar. 2000. Why forest products companies may need to hold timberland. Forest products journal 50(9): 39-44.

Zellner, A., 1962. An efficient method for estimating seemingly unrelated regressions and tests for aggregation bias. Journal of the American Statistical Association 57: 348-368.

IV. Transaction Evidence Appraisal: Competition in British Columbia's Stumpage Markets

This chapter is from Niquidet, K. and van Kooten, G.C. 2006. Transaction Evidence Appraisal: Competition in British Columbia's Stumpage Markets. Forest Science 52(4): 451-459

Abstract

As a potential resolution to the softwood lumber dispute, the US Department of Commerce recommends that administered stumpage prices in Canada be determined using information from competitive timber auctions. Previous research indicates that the degree of competition significantly influences bidding behaviour. In this article, therefore, a truncated hedonic timber sale model was developed to investigate the influence of competition on stumpage markets in the interior of British Columbia. Results indicate that lower bids in several northern zones of the province are due, at least in part, to lack of competition, but that market power appears limited by spatial arbitrage. In one zone characterized by monopsony, we estimate bids are shaded below their true valuation by $\$12.56/m^3$, which approximates the calculated transportation costs ($\$14.90/m^3$) to an adjacent more competitive zone. Furthermore, the significance of the inverse mills ratio suggests that ordinary least-squares regression leads to biased estimates. Our findings have policy implications for the future development and use of transaction evidence appraisal models as a potential solution to the long-standing softwood trade dispute.

Introduction

In Canada, the vast majority of forestland is owned by provincial governments, with rights to harvest trees allocated to forest companies through a variety of tenure arrangements. Historically, stumpage fees charged forest companies for cutting standing timber have been determined administratively rather than via stumpage markets, although administered prices are loosely linked to market prices of wood products such as lumber. A primary example comes from British Columbia (BC), Canada's foremost timber producing region that accounts for about one-half of softwood lumber exports from Canada to the United States.

BC has used Comparative Value Pricing (CVP) since 1987 to set stumpage fees on timber from long-term tenures [1]. Under this system, the fee charged a company on any site is given by: Stumpage = BR + (VI – MVI), where BR is the base rate ($\$$ per m^3) adjusted by the stand's value index (VI) compared to the volume-weighted mean value index (MVI) of all stands. The BR is based on the government's revenue target, while VI

($/m^3) is calculated as the difference between output prices (determined as a composite of lumber and chip prices) and operating costs (as determined by an accounting firm) [2]. The CVP system has been criticized domestically for failing to adjust quickly enough to increasing forest management costs and declining market conditions (Grafton et al. 1998). Yet, the U.S. Coalition for Fair Lumber Imports (hereafter, Coalition) considers the CVP system to be sticky with respect to falling costs and improved output prices, and thus that administered stumpage constitutes a subsidy to Canadian lumber producers.

Not surprisingly, upon the expiry of the quota-based Softwood Lumber Agreement (SLA) in 2001, the Coalition successfully lobbied the U.S. Department of Commerce (DOC) to impose countervailing duties (CVD) on softwood lumber from British Columbia and the other major forest provinces since they also employ administered stumpage. In 2003, the DOC released a proposed framework by which duties could be dropped as a result of a 'changed circumstance' (U.S. DOC 2003). The report stressed that, in order to show that adequate remuneration is collected, provincial administered stumpage fees needed to be based on information from the sale of a sufficient amount of timber at open auction. In doing so, the DOC stated a "strong preference for regression analysis". The regression approach to stumpage appraisal is a form of Transaction Evidence Appraisal (TEA) – a hedonic technique that relates characteristics of timber sales to bid prices. Such calls are not new, as similar proposals were put forth by Scott (1976), previous Royal Commissions (Pearse 1976; Peel 1991) and representatives from BC industry (MacMillan Bloedel 1998).

Since 1999, the BC Ministry of Forests (MoF) has been using a TEA based Market Pricing System (MPS) to establish reservation prices on a small portion of annual harvest auctioned under its Small Business Program (MoF 1999). In response to the DOC proposal, the BC government announced its intent to increase the amount of timber sold at auction to 20% and extend the MPS to set stumpage fees on all timber from public land (MoF 2003). However, a key issue concerning the potential acceptance of a stumpage pricing scheme based on auctions will be the ability of such auctions to replicate a truly competitive market, which may be difficult given potentially low levels of competition. Since timber has low value per unit of weight and is thus costly to transport, stumpage markets may be regionally concentrated (Yin et al. 2002). As Fox (1991) noted, lack of competition is perhaps the biggest drawback to auction-based pricing in BC. However, he did point out that an empirical investigation could be warranted to establish how much of an obstacle this would be.

The main purpose of the current paper, therefore, is to analyze the extent to which lack of competition might be an obstacle to the use of market-based pricing in the setting of stumpage fees on public forestlands. To do so, we employ data from the BC interior. The focus is on the interior, because the vast majority of softwood lumber exported from BC to the U.S. comes from the interior as opposed to the Coast. Further, the structure of the industry and the nature of the timber resource in the interior are more representative of conditions throughout the rest of Canada.

We proceed in the next section by providing a brief overview of timber auction theory and how that has contributed to Transaction Evidence Appraisal modeling, followed by

a regression model for analyzing auction data in BC's interior and the estimation results. The implications for administering stumpage to tenure holders and setting reservation prices in auctions are then discussed, followed by conclusions.

The Development of Transaction Evidence Appraisal Models

The development of TEA models has largely stemmed from theoretical and empirical research on timber auctions that focused on the effects of competition (Mead et al. 1983; Brannman 1996; Johnson 1977), auction design (Johnson 1979; Hansen 1986) and the impact of reservation prices (Huang and Buongiorno 1986; Sendak 1991; Carter and Newman 1998). The underlying framework of the bidding process is a game-theoretic optimum bid strategy (McAfee and McMillan 1987; Bulow and Roberts 1989). A logging company with true value V for timber will win an auction with probability $[F(V)]^{n-1}$, where n is the number of bidders. The expected payment, contingent on winning is given by:

$$(1) \quad B = V - \frac{\int_{u}^{V} [F(x)]^{n-1}\, dx}{[F(V)]^{n-1}},$$

where u is the minimum bid acceptable to the seller, variously referred to as the reserve price or upset price. The bid B in equation (1) is the expected value of the second highest valuation given that V is the highest. Equation (1) predicts that bidders will shade the bid from the true value by an amount representing the bidder's best guess regarding the difference between their valuation and that of the next highest bidder. Assuming everyone follows this strategy, the average winning bid in a first-price, sealed-bid auction will be the second highest valuation (Riley and Samuelson 1981).

The bid shading term is a function of the number of bidders and the reserve price. As n increases, bid shading decreases and bids approach the true valuation, but at a decreasing rate. This theoretical relationship between the number of bidders and the bid for timber has been observed numerous times (Johnson 1979, Mead et al. 1983). Brannman et al. (1987) assigned separate dummy variables for each of n=1, n=2, …, n=11, with the sales with $n \geq 12$ excluded to avoid the dummy variable trap. Assuming that auctions with 12 or more bidders are sufficiently competitive, the coefficients on the dummy variables can be interpreted as the bid shading terms in equation (1). Likewise, dummy variables not statistically significantly different from zero represent competition levels where bids do not differ from valuations substantially [3]. Consequently, it is possible to predict the best estimate of the high bidder's true valuation (V) for the timber.

The aforementioned studies treated the actual number of bidders in the timber sale model as exogenous, however. Brannman (1996) points out that, with a sealed-bid timber sale, the actual number of bidders is not known a priori, so bids should be based instead on the expected number of bidders. Schuster and Niccolucci (1990) were the first to do this in a timber auction setting, using various timber sale characteristics to predict the number of bidders and then including the expected number of bidders in the bid equation. Further, many models fail to account for 'no-bid' information that results

when bids are below the reserve price, potentially biasing estimation results. As shown by Huang and Buongiorno (1986) and Sendak (1991), this bias can be overcome by the use of a limited dependent variable (tobit) model.

To account for both problems, Carter and Newman (1998) developed the following system of equations, estimating parameters using a limited dependent variable, two-stage procedure [4]:

$$(2) \quad B = f[E(n_A),\ u,\ V_{max}(\boldsymbol{X}_1)]$$

$$(3) \quad n_A = g[u,\ n_E(E(B),\ \boldsymbol{X}_2)]$$

where n_A is the actual number of bidders, n_E is the number of expected bidders, u is the upset or reserve price, V_{max} is the highest valuation, $\boldsymbol{X}_1$ is a vector of variables that determines the valuation, and $\boldsymbol{X}_2$ is a set of variables that determines the number of expected bidders.

Consistent with residual value methods, $\boldsymbol{X}_1$ will be made up of variables that influence the selling price of products derived from timber or the costs of converting standing timber into various higher-valued wood products. As suggested by the common-values auction paradigm, $\boldsymbol{X}_2$ would contain variables that influence the heterogeneity of timber values and hence influence pre-sale measurement costs. We would also add that, due to the spatial variation in competition inherent in many stumpage markets, $\boldsymbol{X}_2$ could also contain a series of regional dummy variables.

Explanatory variables could be in $\boldsymbol{X}_2$ as well as $\boldsymbol{X}_1$, thus impacting bids both directly through a valuation effect and indirectly through the number of bidders. Isolating these two effects can help solve the dilemma faced by Nelson et al. (2003) who, in their model of timber sales for the BC interior, noted that observed negative coefficients on the regional dummy variables may be partly due to reduced competition in the area and partly the result of legitimately lower valuations associated with things like higher local operating costs. The two effects that a regional dummy variable has on a bid can then be interpreted with equation (1) in mind. The direct effect reveals the high bidders' true valuations for the resource and the indirect effect reveals the degree to which bids are shaded from that valuation.

A Stumpage Model for the interior of British Columbia

In this study, we employ data from BC's Small Business Forest Enterprise Program. Under 'section 20' of the Program, timber sales were awarded to the highest bidder on the basis of sealed bids. We have data for the period January 1999 to August 2002 that was provided by the Ministry of Forests (Nelson et al. 2003). The data consist of 639 observations, with summary statistics provided in Table 1.

Model

We use a two-equation model similar to that of Carter and Newman (1998), although it differs in three ways. First, E(*B*) is estimated using a truncated model rather than a censored model, as we had no data on 'no-bid' sales. The truncated model is specified as:

$$(4) \quad B_i \mid B_i > u_i = \beta' X_i + \sigma\lambda(\alpha_i)$$

where X_i is a vector of variables determining the bid, σ is the standard deviation of the error term and $\lambda(\alpha_i)$ is the inverse mills ratio, which is defined as:

$$(5) \quad \lambda(\alpha_i) = \frac{f(u_i - \beta' X_i / \sigma)}{1 - F(u_i - \beta' X_i / \sigma)},,$$

where *f* is the standard normal distribution and *F* is the cumulative normal distribution. The inverse mills ratio acts as a proxy for the expected non-zero mean error term brought about by the truncation of bids due to the reserve price. If it is significant in the regression, classical models based on OLS, where the observed bid is regressed on X_i only, suffer from a missing variable problem. In such a case, the OLS parameter estimates (β) tend to be biased downwards, with the exception of the constant term which is biased upwards (Kennedy 1992). In conducting truncated regression we maximize the following likelihood function with respect to parameters β and σ:

$$(6) \quad L = \prod F\left[\left(\boldsymbol{X}_i'\boldsymbol{\beta} - u_i\right)/\sigma\right]^{-1}\sigma^{-1} f\left[\left(B_i - \boldsymbol{X}_i'\boldsymbol{\beta}\right)/\sigma\right], \text{ for } B_i \geq u_i.$$

Second, we do not include the upset price as a regressor in the model as preliminary regressions resulted in multi-collinearity. This collinearity is due to the fact that upset prices for the data were derived from prior regression-based MPS models that use many of the same explanatory variables. Therefore, the upset price is very close to being a linear combination of the other variables in the model [5].

Last, to investigate the various competition levels across the interior, we include several zonal dummy variables.

Table 1: Summary Statistics from BC Interior Auction Sales (639 Observations)

Variable	Mean	Std. Dev.	Min	Max
Bid ($/m^3)	41.55	14.23	0.72	79.75
Truncated Upset Price ($/m^3)	29.53	10.46	0.23	62.34
Number of Bidders	4.915	3.135	1	18
CVD (=1 if sale offered after CVD determination)	0.205	0.404	0	1
Lumber Price Index	103.74	17.147	64.36	160.24
Development Cost ($/m^3)	1.632	2.314	0	26.34
% classified blowdown	0.03	0.106	0	1
% of sale heli logged	0.028	0.15	0	1
% of sale horse logged	0.029	0.165	0	1
% of sale w fire damage	0.006	0.078	0	1
% of gross sale retained	0.078	0.177	0	0.94
Slope	20.247	12.137	0	75
Truck haul time (hours)	4.19	1.87	1.4	11.3
Salvage	0.086	0.281	0	1
% western red cedar	0.026	0.098	0	0.88
% Douglas fir	0.07	0.169	0	0.97
% white pine	0.004	0.027	0	0.32
% hemlock and/or balsam	0.177	0.294	0	1
Volume per hectare (m^3 / ha)	280.251	117.887	15	748.02
Cruise Volume (m^3)	11669.45	7790.52	4000	49560
Average net cruise volume per tree (m^3)	0.529	0.269	0.08	1.75
2nd Quarter (=1 if timber sale in 2nd Quarter, else 0)	0.205	0.404	0	1
Fort Nelson Region	0.006	0.079	0	1
Far North Region	0.16	0.367	0	1
Central North Region	0.163	0.369	0	1
North-West Region	0.133	0.34	0	1

Results

We started off with a preliminary reduced-form bid model that assigned dummy variables to several small sub-regions and forest districts. Several of the coefficients on these dummy variables were very close in sign and magnitude. Therefore, using Wald tests, we grouped the smaller sub-regions and districts together to form broader zones. The Northern Interior Region was divided into four zones with each assigned a dummy variable, whereas the Southern Interior Forest Region was treated as a homogenous market and included in the constant term [6]. Regression results for both the reduced-form bid and number of bidders equations are presented in Table 2, as are the results of the OLS reduced-form bid equation. A comparison of the maximum likelihood estimates from the truncated model with the OLS estimates confirms the anticipated bias of the latter estimates. The coefficients on the explanatory variables estimated by OLS are smaller and the intercept higher than the unbiased Maximum Likelihood estimates. The statistical significance of the inverse mills ratio, $\lambda(\hat{\alpha})$, suggests that this bias is statistically significant.

Table 2: Reduced Form Bid and Number of Bidders Equations

	Bid equation, Tobit		Bid equation, OLS		Ln (Number of bidders)	
Explanatory Variable	Estimated coeff.[a]	Std. error	Estimated Coeff.[a]	Std. error	Estimated coeff.[a]	Std. Error
Intercept	14.923*	8.435	18.505***	5.604	1.811***	0.455
=1 if sale offered after CVD determination	-5.213***	1.343	-3.728***	0.857	0.136*	0.070
Lumber price index	0.287***	0.029	0.271***	0.019	0.000	0.002
Develop. Cost ($/m^3)	-0.752***	0.236	-0.646***	0.139	-0.006	0.011
% classified blowdown	-8.774**	4.384	-9.791***	2.781	0.189	0.226
% of sale heli logged	-58.595***	5.566	-39.740***	1.986	-0.864***	0.161
% of sale horse logged	-20.052***	3.491	-14.219***	1.868	-0.575***	0.152
% of sale w fire damage	-20.666***	6.772	-17.105***	3.742	0.097	0.304
% of gross sale retained	-9.790***	3.165	-6.607***	1.999	-0.380**	0.162
Slope of site	0.368***	0.125	0.272***	0.080	0.004	0.007
Slope of site squared	-0.011***	0.002	-0.009***	0.001	0.000**	0.000
Truck haul time (hours)	-2.382***	0.280	-2.089***	0.175	-0.040***	0.014
Salvage (=1, else 0)	-2.036	1.850	-2.448**	1.246	-0.050	0.101
% western red cedar	5.673	4.504	3.876	3.192	-0.178	0.259
% Douglas fir	10.964***	2.805	8.255***	1.997	0.556***	0.162
% white pine	32.846**	15.362	20.125*	10.822	-1.876**	0.879
% hemlock and/or balsam	-18.894***	3.256	-13.485***	2.077	-1.064***	0.169
Volume per hectare (m^3/ha)	0.003	0.006	0.008**	0.004	0.001*	0.000
Log of cruise volume	2.109***	0.815	1.696***	0.540	-0.002	0.044
Log of average net cruise volume per tree	10.729***	1.277	9.051***	0.817	0.138**	0.066
=1 if timber sale in 2nd Quarter, else 0	3.720***	1.086	2.723***	0.733	0.323***	0.060
Fort Nelson region	-23.320**	9.888	-11.711***	3.765	-1.031***	0.306
Far North region	-10.671***	1.702	-8.590***	1.020	-0.121	0.083
Central North region	-7.379***	1.378	-5.180***	0.858	-0.217***	0.070
North-west region	1.539	2.654	0.174	1.709	0.184	0.139
Inverse mills ratio, λ	8.542***	0.360				
Adjusted R^2	0.78		0.75		0.29	
Log Likelihood Ratio	363.87***					
F Statistic			79.66***		11.93***	

[a] *** indicates statistical significance at 1% level or better, ** at 5% level, * at 10% level.

The variables volume per hectare, percent western red cedar, 'salvage' and the North-West region were the only variables in the bid equation not statistically significant at the 10% level of confidence or better. The lack of statistical significance for 'salvage', which is attributable to damage by the Mountain Pine Beetle (MPB), is somewhat surprising given that this wood is presumably of lower quality. Further, salvage material often gluts local markets, depressing prices (Prestemon et al. 2001). For the data in our sample, the majority of MPB-salvage timber originates with the Central North Region, so lower prices may be showing up in the coefficient for the

dummy variable for this region. Another possible explanation for this result is the log grading system used in the Interior. The timber bid is for sawlog grades only; all other grades are charged a flat fee of $0.25/m^3$. This flat fee is likely an underestimate of the value of the fiber. Since salvage sales often contain significantly more non-sawlog grades, bidders may bid higher than market value on the sawlogs, knowing they are getting non-sawlog timbers at less than market value. If this phenomenon occurs on a large scale, and is not properly controlled for in the regression, it could potentially distort TEA results. As the current MPB epidemic continues to grow in British Columbia, this may become a significant issue with future MPS models, requiring that changes be made to the grading system.

The countervail duty (CVD) dummy variable is equal to 1 if the timber sale occurred after the latest CVD was imposed, and zero otherwise. Results indicate that imposition of the latest countervail duty caused bids to drop some $5.21/m^3$. Under a market-based pricing system and when faced with lower output values (e.g., due to a CVD), firms will adjust their input costs leaving output unchanged. Hence, if the goal of U.S. duties is to restrict the flow of wood into the domestic market, an import tax (price) is less likely to succeed than a quantity restriction (quota), as also argued by van Kooten (2002).

If the appraisal is accurate, the coefficient on development costs (road building) should equal one, with values less than one implying that appraised development costs are overestimates. For example, Brannman (1996) found evidence that the 'purchaser credit limit' given to loggers on U.S. National Forests for road construction was too generous. However, the appraisal rate is based on an operator of 'average efficiency', and presumably the high bidder in a competitive auction is better than average.

The coefficients on northern zones were negative as expected, although the estimated coefficient for North-West was insignificant, suggesting that bids in that region do not differ from the Southern Interior Region. We found this result contrary to prior expectations since the region's manufacturing sector is rather concentrated and, for much of the time in our sample, the largest timber processor was idle due to financial hardship. Further investigation revealed that, because of poor economic conditions in the region at the time, timber was often deemed surplus to domestic requirements and granted exemptions from log export restrictions. Given the region's close proximity to tidewater, timber could have been transported to domestic coastal, U.S. and/or Asian markets.

Dummy variables for the Fort Nelson, Far North and Central North zones are highly statistically significant with negative coefficients. Since these variables are also significant (Far North marginally significant) in the number of bidders equation, this suggests that lower bids in these zones are partly attributable to reduced competition. To quantify just how much the lower competition affects the bidding results, it is necessary to obtain the structural coefficients of the bid model. These are provided in Table 3.

Table 3: Structural Bid Equation

Explanatory variable	Estimated coefficient	Standard error
Intercept	6.689	9.636
Sale offered after latest CVD implemented (=1, else 0)	-6.529**	1.583
Lumber selling price index ($/m³)	0.288**	0.030
Development cost ($/m³)	-0.712**	0.238
% of sale classified as blowdown	-11.509*	4.672
% of sale logged by helicopter	-48.489**	8.193
% of sale logged by horse	-13.794**	4.881
% of sale with fire damage	-20.406**	6.709
% of the gross sale retained	-1.758	3.273
Slope of site	0.285*	0.132
Slope of site squared	-0.008**	0.003
Truck hauling time (hours)	-1.960**	0.371
Salvage (=1 if salvage sale, else 0)	-1.043	1.941
% western red cedar	6.453	4.653
% Douglas fir	6.112	4.049
% white pine	54.814*	22.925
% hemlock and/or balsam	-7.627	7.674
Volume per hectare (m³/ha)	0.002	0.006
Log of net cruise volume (m³)	2.074*	0.820
Log of average net cruise volume per tree (m³)	9.137**	1.484
=1 if timber sale in 2nd Quarter, else 0	1.109	2.060
Fort Nelson region	-9.021	13.362
Far North region	-9.639**	1.803
Central North region	-5.614**	1.808
North-West region	-0.711	2.840
Log of forecasted expected number of bidders	12.185	7.961
Inverse mills ratio, λ	8.593**	0.363
Adjusted R^2	0.78	
Log Likelihood Ratio	362.22**	

[a] ** indicates statistical significance at 1% level or better, * at 5% level or better.

Reduced competition in the northern zones affects bids in the following manner: Fort Nelson: $-12.56/m³ (=12.185×-1.031); Far North: $-1.47/m³ (=12.185×-0.121); and Central North: $-2.64/m³ (=12.185×-0.217). If the Southern Interior (which is included in the intercept term) is assumed to have sufficient competition [7] so bids approximately reflect true valuations, the above adjustments can be interpreted as the levels of bid shading. The level of bid shading for Fort Nelson corresponds closely with what one might expect given that there is only one significant manufacturer in this district. The nearest competitor is located in Fort St. John, approximately 380 km away. The amount by which the bid is shaded is about equal to the transportation cost to nearest alternative sawmill in Fort St. John [8]. This result is also consistent with the optimum bid strategy developed by McAfee and McMillan (1987); bids reflect the bidder's best guess as to the next highest bidder's valuation.

Bid shading in the Far North and Central North is rather marginal and may not be entirely due to the structure of the underlying manufacturing sector. In the Central North there is a large supply of timber due to increased harvests due to the mountain pine beetle, while, in the Far North, alternative supplies from Alberta and the Yukon are available. Many mills have enough wood in their own or associated tenures, and this likely contributes to a lowered expected level of competition at auctions. The 20% tenure take back currently being implemented by the government will likely increase the expected level of competition at auctions because firms will have to enter the market more frequently to supply their mills. The positive coefficient on the CVD dummy variable in the number of bidders equation lends support to this hypothesis. Since the imposition of the countervail duty, it is widely known that interior mills have increased their capacity in an attempt to drive down unit costs, leading to increased demand for wood and more bidders participating in timber auctions.

The availability of alternate supplies and capacity levels may also influence valuations. Haile (2001) shows the option value of a timber sale is influenced by resale opportunities. When the option value of buying in the resale market is high, bidders' valuations are lower. Furthermore, the value of timber for a firm with excess capacity reflects not only the revenue it can receive from the conversion of the timber, but also the reduced unit costs that come about from increasing output (Schwindt 1992).

Many of the significant variables in the number of bidders equation correspond to the theoretical common-values auction paradigm. Higher bid preparation costs are usually associated with uncertainty, which might explain the reduced number of bidders associated with interior 'wet-belt' species such as hemlock, cedar and white pine. Stands in the interior wet belt have higher rates of decay and are more diverse than other stands. Timber cruises in these stands are subject to higher sampling error, so bidders will probably conduct their own cruises. This results in higher bid preparation costs and a reduced number of bidders.

Implications for Upset rate and Administered Pricing Policy

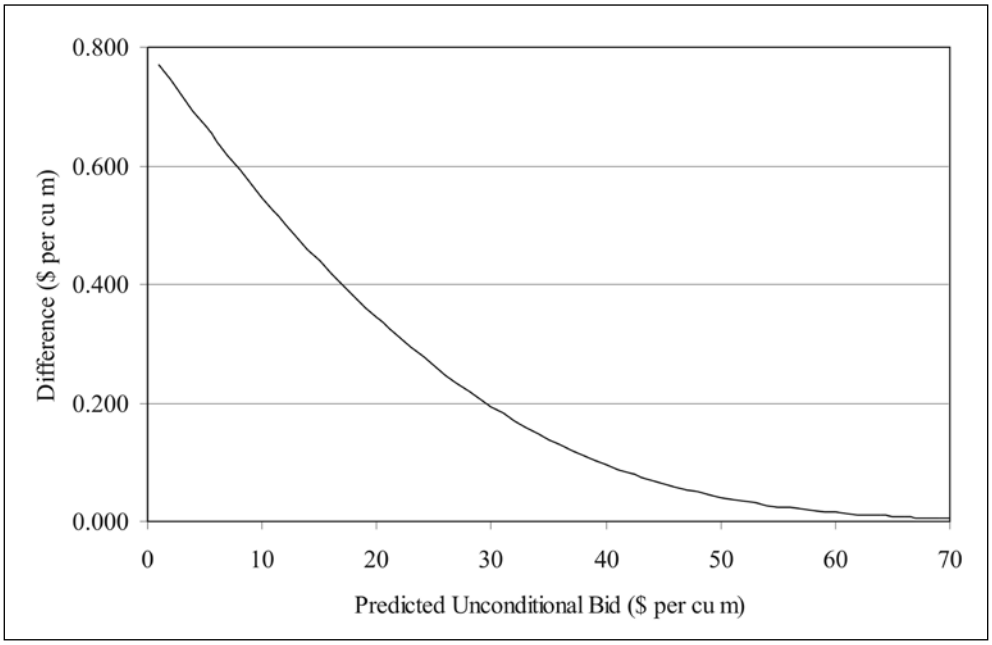
Existing market pricing system models used in British Columbia are based on OLS. The significance of the inverse mills ratio in our model suggests that these models are statistically biased and should be replaced by some form of limited dependent variable model. The higher constant and lower coefficients in the OLS model imply that MPS would tend to overvalue lower-valued stands and undervalue higher-valued stands. Our use of the truncated model was based on data availability. Future analysis should incorporate 'no-bid' sale information and apply more robust modeling techniques, such as the Heckman sample selection model where selection (truncation) is endogenous [9].

Previous researchers have referred to the predicted latent variable ($\boldsymbol{X}\hat{\boldsymbol{\beta}}$) as the market value (Huang and Buongiono 1986; Sendak 1991; Carter and Newman 1998; Boltz et al. 2002), but, since the latent variable reflects only the buyer side of the market,

the term 'market value' may not be appropriate. Buyers' willingness to pay and sellers' willingness to accept determine a market value. The latent variable does not consider the conditions of the seller, so it is referred to as the 'unconditional bid'. The predicted conditional high bid $\boldsymbol{X\hat{\beta}} + \hat{\sigma}\lambda(\hat{\alpha})$ is technically a better estimate of the bid one would observe in the market. What then should be the conditions of the seller?

As it stands now, upset prices in British Columbia are set in the same manner throughout the province; the predicted high bid estimated by the MPS model is 'rolled back' by 30% to stimulate bidding and accommodate statistical variability in the prediction. The use of a 30% rollback factor was chosen to reflect U.S. Forest Service practice. Using our estimate of $\hat{\sigma}$ given in Table 3 (the coefficient on the inverse mills ratio) and an upset rate given as 70% of the unconditional high bid, we calculated the difference between the two predicted values $[\hat{\sigma}\lambda(\hat{\alpha})]$ for expected unconditional bids ranging from one dollar to seventy dollars. These are shown in Figure 1.

Figure 1. Difference between Predicted Unconditional and Conditional High Bids



The difference between the two values reflects the degree of truncation caused by the upset price. The 30% rule has a greater truncation effect on low values than high ones, causing a greater gap between the two predicted values. Such a rule largely ignores the regional variations in competition, however. Furthermore, it no longer concurs with U.S. Forest Service policy as recent timber sale preparation handbooks recommend changing the rollback according to competition levels, ranging from 10% to 20% in competitive regions and 0% to 5% in non-competitive markets.

We would define competitive timber auction markets as those that have a sufficient

number of bidders so that bid shading is small and bids reflect actual valuations. In British Columbia, homogeneity of timber bids and measures of timber processing concentration suggest that the Southern Interior Region fits this definition. Predicted high bids could be rolled back measurably without prompting competition concerns. This will be particularly true if British Columbia relaxed its log export policy, as trucking timber to sawmills in the States of Idaho, Montana and Washington would be economically feasible [10]. Indeed, we believe evidence of the benefits of log exports on competition levels, and hence bids, is evident in our data for the North-West Region. Allowing more log exports would be consistent with Bulow and Klemperer (2002) who suggest that it is typically more productive for a seller to expand the market rather than attempt to set an optimal reserve price. Nonetheless, to date complete relaxation of log exports has been considered politically infeasible because log exports are viewed as job exports, prompting public outrage. This is in spite of research to the contrary (Margolick and Uhler 1992).

Because of high transportation costs, allowing log exports to the U.S would do little to improve competition in Northern BC where our research indicates increased competition would be most beneficial. Further, fixed timber supplies and economies of scale also create natural barriers to entry. Thus, bid shading is significant, and policy makers are faced with the decision as to whether to allow spatial arbitrage to continue to occur or to set upset prices to capture the surplus accruing to timber buyers. For the Fort Nelson zone, shading is rather substantial and we would recommend that the province capture the surplus by setting upset rates with reference to adjacent competitive regions with some recognition of local operating conditions but with little to no rollback. Our model provides a potential mechanism for this as the competitive high bid could be forecast by removing bid shading from the predicted unconditional high bid (B): $E(V)=E(B)+E(\text{bid shading})$. In the predictive process this would mean not employing the negative coefficient on the Fort Nelson regional dummy variable in the number of bidders equation. A similar process could be used in the other Northern zones. In these zones, fostering competition in the local timber market may be better accomplished, however, by taking away harvest rights and allocating it to independent forest managers who do not own or operate manufacturing facilities.

Now consider the implications of BC's market-based pricing system for setting stumpage fees for licensees with long-term tenures on public forestland. The DOC demands that Canadian administered fees replicate the values determined in an open competitive market. As we suggested earlier, the predicted conditional high bid best represents what one would observe in the marketplace. This means reserve prices in auctions potentially impact administered prices, but the seller's reserve price is largely there to protect against collusion. In an administered setting, if one can model a competitive result free of bid shading, no conditions should be placed on the sale; therefore, the predicted competitive high bid $E(V)$ would be the market value. This predicted value addresses concerns over validating lack of competition in an administered stumpage system using TEA. It can be argued that, in spite of a competitive market, conditions could still be placed on the sale to ensure costs to the seller are recovered.

In British Columbia, however, most of the costs related to forest management and reforestation are the responsibility of the licensee. The public authority still incurs some administrative, compliance, enforcement and opportunity costs, but these can be recovered by setting appropriate minimum administered stumpage fees. The stumpage rate charged to non-auctioned cutting authorities would therefore be the maximum of the predicted competitive high bid less appraised allowances for forest management planning and silviculture, or the net opportunity cost incurred by the Province as a result of harvesting [11]. The use of the competitive high bid would go a long way in showing that adequate resource rents are collected. Additionally, an appropriate minimum stumpage fee would ensure harvesting is within the extensive margin, and therefore domestic and international prices are not artificially deflated (Nordhaus 1992).

Conclusions

In British Columbia increased reliance on timber auctions to allocate harvesting rights and set stumpage fees will not come without challenges. A central challenge in the setting of reservation and administered prices based on transaction evidence appraisal is dealing with varying competition levels throughout the province. While this issue is sure to be contentious, failure to address it would significantly impede the success of an auction based system. In this paper, we show that competition levels in BC's Northern Interior reduce bids for standing timber. A TEA system that does not address this phenomenon will be susceptible to criticism from both domestic and U.S. sources.

Within British Columbia, the distribution of rents that stem from an auction system that does not account for (lack of) competition will evoke concerns from the public as resource owner, because they lose of a portion of the revenue which could fund valuable services such as health and education. Furthermore, equity issues could potentially be a concern as tenure holders in non-competitive regions would have an unfair advantage. This has implications for competitors within the province and outside. In particular, lack of competition and seemingly obscure setting of stumpage charges are a source of contention with the U.S., enabling the Coalition to continue lobbying the Department of Commerce for countervail action against softwood lumber from Canada.

To meet these challenges we recommend a relaxation of log export restraints and further separation of forest management functions from manufacturing and processing of wood. Both these policies are likely to be politically controversial and unlikely to be implemented without concomitant assurances of access to U.S. lumber markets. The current research provides an enabling mechanism for encouraging steps toward the resolution of the softwood lumber dispute, namely, a means to estimate the true stumpage value of timber in regions where there is lack of competition, thereby making transaction evidence appraisal information more palatable to U.S. interests. The approach presented in this paper can form the basis for an appropriate reservation pricing policy and an operational administered stumpage system in British Columbia.

Endnotes

1. For a discussion of the tenure system, see van Kooten and Folmer (2004, pp.389-393). Companies with long-term cutting licenses also have forest management responsibilities and until recently (2003) were often subject to appurtenance clauses which tied timber from the license to a manufacturing facility.
2. For more details see van Kooten and Folmer (2004, pp.58-64).
3. Brannman, Klein and Weiss found that the dummy variable became statistically insignificant at five bidders for sealed-bid auctions and nine bidders for oral-bid auctions. We found a similar result using data described in the section three, except that the dummy variables became statistically insignificant when there were eight or more bidders.
4. In the first stage, the expected bid, E(B), and number of bidders, E(n_A), are estimated using the reduced-form equations. The bid equation is estimated by limited dependent variable techniques and number of bidders by OLS. The second stage involves re-estimating both equations using the predicted values estimated in the first stage (see Nelson and Olsen 1978).
5. The upset price does in fact enter the model, albeit in a non-linear fashion as the truncation point in the inverse mills ratio. Technically the upset price would be an acceptable bid; therefore the truncation point was set at the upset price less one cent, which is termed the truncated upset price in table 1.
6. The zones are: Far North, consisting of the Peace, Mackenzie and Ft. St. James Districts; Central North, consisting of the Prince George, Vanderhoof and Nadina Districts; North-West, consisting of the Kalum, Kispiox and Bulkley-Cassiar Districts; and the Fort Nelson Forest District. The dummy variables on the Cariboo and Nelson sub-regions were not significantly different from the Kamloops region, which was included in the constant term. Collectively these three regions make up what is termed the Southern Interior.
7. Based on 2002 mill data, this region has a Herfindahl Index (= $\sum_{i=1}^{N} s_i^2$, where N is number of firms and s_i is the share of firm i measured in %) less than 1000.
8. The calculation is: 380 km at 100 km/hr = 3.8 hrs × 2 = 7.6 hour cycle time. Given the structural coefficient for cycle is 1.96, the transportation cost is 7.6 1.96 = \$14.90/m³.
9. The censored model used by Carter and Newman (1998) is a restricted version of the Heckman model (see Amemiya 1984).
10. We might add that the same competition benefits would also accrue to U.S. Forest Service timber sales by adopting similar policies, as mills in Southern British Columbia would increase competition in U.S. stumpage markets. The caveat is that trade barriers in lumber are removed.

11. These include recreational and wilderness benefits foregone, which could be estimated by non-market valuation techniques such as benefits transfer. The challenge will be to estimate the value of these non-priced goods at the margin. Further complicating matters, harvesting potentially has external benefits as well.

Literature Cited

Amemiya, T. 1984. Tobit models: a survey. J. of Econometrics. 24: 3-61.

Boltz, F., D.R. Carter, and M.G. Jacobson. 2002. Shadow pricing diversity in U.S. National Forests. J. of For. Econ. 8: 185-197.

Brannman, L.E. 1996. Potential competition and possible collusion in Forest Service timber auctions. Econ. Inq. 34: 730-745.

Brannman, L.E., J.D. Klein and L. Weiss. 1987. The price effects of increased competition in auction markets. Rev. of Econ. and Stat. 69: 24-32.

Bulow, J. and P. Klemperer. 2002. Prices and the winner's curse. RAND J. of Econ. 33: 1-21.

Bulow, J. and J. Roberts. 1989. The simple economics of optimal auctions. J. of Pol. Econ. 97(5): 1060-1090.

BC Ministry of Forests. 2003. The forestry revitalization plan. Government of British Columbia, Victoria, Canada.

BC Ministry of Forests. 1999. The market pricing system (Coast) / the market pricing system (Interior). Revenue Branch Report. Government of British Columbia, Victoria, Canada, January 25.

Carter, D.R. and D.H. Newman. 1998. The impact of reserve prices in sealed bid federal timber sale auctions. For. Sci. 44: 485-495.

Fox, I.K. 1991. Politics of Canada-U.S. trade. In Canada-U.S. trade in forest products, R.S. Uhler (ed). University of British Columbia Press, Vancouver, Canada.

Grafton, R.Q., R.W. Lynch, and H.W. Nelson. 1998. British Columbia's stumpage system: economic and trade policy implications. Can. Public Policy. 24: S41-S50.

Haile, P. 2001. Auctions with resale markets: an application to U.S. Forest Service timber sales. Am. Econ. Rev. 92: 399-427.

Hansen, R.G. 1985. Empirical testing of auction theory. Am. Econ. Rev. 75(May): 156-159.

Huang, F.M. and J. Buongiorno. 1986. Market value of timber when some offerings are not sold: implications for appraisal and demand analysis. For. Sci. 32(4): 845-854.

Johnson, R.N. 1977. Competitive bidding for federally owned timber. Ph.D. dissertation, Univ. of Washington, WA.

Johnson, R.N. 1979. Oral auction versus sealed bids: an empirical investigation. Nat. Res. J. 19: 315-335.

Kennedy, P. 1992. A guide to econometrics. 3rd Edition. MIT Press, Cambridge, MA.

Margolick, M., and R.S. Uhler. 1992. The economic impact on British Columbia of removing log export restrictions. In Emerging issues in forest policy, P.N. Nemetz (ed.). UBC Press, Vancouver, Canada.

McAfee, R.P., and J. McMillan. 1987. Auctions and bidding. J. of Econ. Lit. 25: 699-738.

Mead, W.J., M. Schniepp, and R. Watson. 1983. Competitive bidding for Forest Service timber in the Pacific Northwest 1963-83. USFS Contract No. 53-3187-2-59, Washington.

Nelson, F., and L. Olson. 1978. Specification and estimation of simultaneous-equation model with limited dependent variables. Internat. Econ. Rev. 19: 695-709.

Nelson, H., A. Krcmar, K. Niquidet, G.C. van Kooten, and I. Vertinsky. 2003. Evaluating the socio-economic impacts from expanding the use of auction systems for timber in BC. Report prepared for the Forestry Innovative Investment Forest Research Program. FEPA Research Unit, Univ. of British Columbia.

Nordhaus, W.D. 1992. The impact of stumpage charges on prices and trade flows in forest products, Appendix A to memorandum concerning alleged subsidies and preferentiality in the matter of certain softwood lumber products from Canada. INV. C-122-816. International Trade Administration, US Department of Commerce, Washington.

Pearse, P.H. 1976. Timber rights and forest policy in British Columbia. Report of the Royal Commission on Forest Resources. Queen's Printer, Victoria, Canada.

Peel, S. 1991. The future of our forests. Forest Resources Commission Report, Victoria, Canada.

Prestemon, J.P., J.M. Pye, and T.P. Holmes. 2001. Timber economics of natural catastrophes. In Proc. of the 2000 Southern forest economics workshop, March 26-28, Pelkki, M. (ed.). Lexington, KT.

Riley, J.G., and W.F. Samuelson. 1981. Optimal auctions. Am. Econ. Rev. 71: 381-392.

Schwindt, R. 1992. Report of the Commission of Inquiry into Compensation for the Taking of Resource Interests. Government of BC Printing Office, Victoria, Canada.

Scott, A. 1976. The cost of compulsory log trading. In Timber policy issues in British Columbia, McKillop, W. and W.J. Mead (eds.). University of British Columbia Press, Vancouver, Canada.

Schuster, E.G., and M.J. Niccolucci. 1990. Comparative accuracy of six timber appraisal methods. Appraisal J. 58: 96-108.

Sendak, P.E. 1991. Timber sale value as a function of sale characteristics and number of bidders. Research Paper NE-657. USDA Forest Service, Northeastern Forest Experiment Station, Radnor, PA.

U.S. Department of Commerce. 2003. Proposed analytical framework for softwood lumber from Canada: Discussion Draft". Washington DC.

van Kooten, G.C. 2002. Economic analysis of the Canada-United States softwood lumber dispute: Playing the quota game. For. Sci. 48(November): 712-721.

van Kooten, G.C. and H. Folmer. 2004. Land and forest economics. Edward Elgar, Cheltenham, United Kingdom. 533 p.

Yin, R., D.H. Newman, and J. Siry. 2002. Testing for market integration among southern pine regions. J. of For. Econ. 8: 151-166.

V. Pricing the social contract in the British Columbian forest sector

This chapter is from Niquidet, K. Nelson, H. and Vertinsky, I. 2007. Pricing the social contract in the British Columbian forest sector. Accepted April 13, 2007. Canadian Journal of Forest Research.

Abstract

In this paper we investigate the impact of various socio-economic conditions on the value of timber tenures in the province of British Columbia. Two timber tenure models were created, one for short-term Timber Sale Licenses and the other for longer term Forest Licenses. The short-term model revealed that timber sales which were awarded according to a combination of employment, revenue and manufacturing criteria yielded $\$8.63/m^3$ less revenue than timber sales awarded based on revenue alone. Similarly, the long-term model indicates that manufacturing and employment conditions significantly reduce the bid on Forest Licenses. In both instances, we suggest that such conditions distort the use of timber, labour and capital. Therefore we conclude that recent forest policy changes in the province that removed several of these conditions greatly improved economic efficiency. Nevertheless, distribution impacts are likely to be important, as resource rents have potentially been re-distributed away from rural communities to the provincial government.

Introduction

In Canada, forest ownership is predominately held by provincial governments. Each province has created its own unique tenure system which grants harvesting rights to private forest companies. In the largest timber producing region, British Columbia, there exists a complex array of tenure arrangements which vary according to their management responsibilities, term, and structure (i.e. area vs. volume based). Comprehensive descriptions of each tenure type can be found in numerous sources (van Kooten and Folmer 2004; Luckert and Haley 1990; Cashore et al. 2001) and are therefore not repeated in this paper. Prior research has shown that the nature of these arrangements has a significant impact on investments in enhanced silviculture (Zhang and Pearse 1996) and reforestation (Zhang and Pearse 1997), as well as on the value of the tenure itself (Zhang 1996).

Historically, many timber tenure arrangements in British Columbia, and in Canada for that matter, have been designed to meet a variety of socio-economic goals such as increasing regional employment and value added, as well as providing opportunities for

small operators. Collectively these tenure conditions have been dubbed as being part of a broader "social contract" between forest dependent communities and license holders. Virtually no work however has been done on quantifying the costs or benefits of these various tenure conditions.

To a large extent the lack of work in this area has probably been the result of the inadequate market transactions for timber tenures throughout the country. Tenures in Canada are often awarded via bilateral negotiations between industry and government or on the basis of non-price criteria, and transactions between companies regularly include other assets, making the assessment of the value of tenure on its own difficult.[1] Zhang (1996) notes this restriction, limiting his analysis in British Columbia to the Timber License tenure, the only tenure where he had a sufficient amount of market transactions. Timber Licenses however govern a very small portion of the annual timber harvest in the province and their award has ceased. Furthermore, unlike many of the other tenures in the province, they are relatively free of employment and manufacturing conditions.

Tenures coming from the province's Small Business Forest Enterprise Program (SBFEP) on the other hand were full of such conditions. The SBFEP was designed to facilitate new entrants and to provide timber supplies to smaller loggers and manufacturers, particularly those with a focus on job and value added creation. As part of the province's 2003 forestry revitalization regime, the SBFEP was restructured, increasing in size and receiving a new, revenue focused, directive. To reflect this, many of the socio-economic tenure conditions were dropped and the program was re-named British Columbia Timber Sales (BCTS). The primary goal of this paper is to assess the benefit of dropping these conditions, or seen another way, to assess the cost in terms of forgone rents of the various SBFEP aspirations. The results of this study can help guide policy makers both in Canada and in other forest jurisdictions who have similar socio-economic goals.

The structure of the paper is the following. In the first section some background is provided which outlines the organization and goals of the SBFEP, this is followed by a description of BCTS, its organization, and its mandate. The ensuing section presents the methodology for two timber market models, one for short-term timber tenures and the other for longer term tenures. The goal of each model is to establish the shadow price of various employment, processing and size constraints. The results of these empirical models are then presented in the next section. A discussion and our conclusions follow in the subsequent sections.

Background

Small Business Forest Enterprise Program

The creation of the SBFEP in 1980 resulted from the recommendations of the royal commission conducted by Pearse (1976). In his report he voiced concern about the

1 This was largely due to appurtenancy clauses which tied timber tenures to manufacturing facilities.

lack of opportunity new entrants and smaller producers had in the forest sector, which stemmed from the full allocation of Annual Allowable Cuts (AACs) to major integrated forest products companies. The program began small, as it was initially allocated a small portion of the provincial AAC, but this was expanded in the late 1980s and 1990s in an effort to reverse the declining employment and value added in the provincial forest economy (M'Gonigle and Parfitt 1994). These expansions brought the size of the program up to approximately 13% of the provincial AAC.

There were three types of registrants in the SBFEP:

1. *Category 1* - market loggers, who harvest timber and do not do any processing.
2. *Category 2* – sawmill owners who had no replaceable tenure, value added primary processors and remanufactures.
3. *Category 3* – registrants who do not have a mill or processing facility but commit to building one. Corporations holding licenses with an AAC greater than 10,000 m^3 are not eligible, however. Once category 3 registrants are awarded a timber sale and a timber processing facility is built, they would then enter category 2.

Each of these registrants was eligible, in varying degrees, for the award of public timber.

Section 20 of the program awarded short-term timber sale licenses (TSLs) to eligible registrants solely on the basis of revenue. This was accomplished by a first price, sealed bid auction. Unlike many of the other provincial tenures, a TSL carried with it no pre-harvesting management responsibilities, as the SBFEP designed the logging unit and submitted the various management plans to the appropriate government ministry for approval. Furthermore, the license holder was not responsible for reforesting the site after harvesting, as this duty was also carried out by the SBFEP. Effectively the license was strictly for the right to harvest and sell the designated timber within the unit boundaries within an established time frame, which was usually around a year but occasionally up to 4 years. The majority of section 20 sales were open to market loggers registered in category 1. In some cases, however, the sale only offered a small volume or required labour intensive extractive methods (e.g. horse logging), which had the effect of deterring larger companies. In addition, on frequent occasions bidding was restricted to those with registration in category 2.

The other major type of SBFEP TSL was Section 21 sales. These sales targeted firms who planned to maintain, expand or build value added processing facilities. As a result, eligible bidders were restricted to category 2 registrants, but occasionally were open to category 3 members. Unlike section 20 sales however, the award of section 21 TSLs was based on a combination of revenue and non-revenue criteria. Accordingly, section 21 sales were often termed bid proposals. This was reflected in the stated objectives of the section 21 program (British Columbia Ministry of Forests and Range 2006):

1. To provide opportunities for innovation and entrepreneurs in independent smaller firms;
2. To encourage and promote greater employment and community stability through economically sound and viable remanufacturing and the production of specialty wood products by independent remanufactures in British Columbia; and,
3. To award sales competitively.

The usual criteria and the respective weighting each criterion received in the award of a bid proposal are shown in table 1 (*Ibid*).

Table 1. Criteria and weighting for the award of Bid Proposals

Criterion	Weighting (percent)
Employment	30
Proximity	10
Existing Plant	10
New capital investment	10
Labour value-added	5
Change in value-added	15
Revenue	20

The SBFEP also awarded longer term non-replaceable Forest Licenses (NRFLs) to those registered in categories 2 and 3. Unlike the TSLs, NRFLs did not specifically identify the timber which was to be harvested. Instead they grant an annual cut level within a broad geographical area and the licensee is responsible for pre-harvest planning, including the design and inventory of the logging unit and reforesting the site after harvesting. Prior to the Forestry Revitalization Plan (FRP) these NRFLs were typically awarded through the SBFEP based on what the application brought in terms of revenue (as offered by lump sum bid), employment and processing. Furthermore, unlike TSLs where stumpage fees are determined by the auction bid, timber harvested from NRFLs is subject to a volumetric administered stumpage fee, which is derived from a pricing formula.

British Columbia Timber Sales

BCTS came into existence on 1 April 2003 following the announcement of the FRP. In contrast to the SBFEP its stated objective is:

> "BCTS aims to generate the best possible financial return to the Crown from publicly-owned timber, provide timber opportunities, and set a credible reference point for the price and cost of timber harvested from Crown land." (BCTS 2006)

To meet the first objective, BCTS no longer offers section 21 sales, reallocating this volume to section 20 where it is awarded strictly to the highest bidder. Furthermore, major integrated tenure holders who hold greater than 10,000 m^3 of AAC will no longer be excluded from registering in category 1. For an undisclosed temporary period however, some sales will continue to be restricted to category 2 registrants. In addition, BCTS will presumably increase the size of its sales and will eliminate the practise of setting aside special horse logging sales, unless forest management objectives dictate.

To meet the other two objectives, increased volumes will flow through the program; moving from approximately 13% of the provincial AAC to 20%. This volume should also lessen any entry barriers as the additional volume will be sourced from the timber "take back" which re-allocates 20% of the volume from long-term renewable tenures held by large integrated forest companies to BCTS, community forest licenses, small

woodlots, and first nations groups. With the 20% auctioned under BCTS now to be used to derive a new pricing formula on long-term area and volume based tenures.

BCTS also will no longer auction NRFLs, as all of this volume flowed into section 20. In spite of this, the government has had some additional volume available to it as a result of uplifts to AACs in areas impacted by the mountain pine beetle infestation. With this volume, the Ministry of Forests and Range, rather than BCTS, created and auctioned several new NRFLs. Although the award of these new NRFLs was strictly based on the highest bid measured by revenue, the design of many of these licenses suggests that there was a concerted effort to foster new entrants in processing, particularly in non-lumber forest products. For on several occasions bidding was restricted to those who would commit to building new non-lumber processing capacity. It was hoped that this capacity will divert volume away from U.S. softwood lumber markets, thus attempting to remove the possibility of affecting their domestic producers, who - as history has shown - have been successful at lobbying for trade restrictions.

Methodology: Timber Market Models

Short–term timber sales

A dataset of TSLs issued in the Interior of the Province under both the section 20 and section 21 programs from January 1999 to June 2004 was retrieved from the BC Ministry of Forests and Range. Table 2 summarizes the number of sales in each year by category.

Table 2. Timber sales by category and year

	Section 20		Section 21	
Year	**Category 1**	**Category 2**	**Bid Proposal**	**Total**
1999	312	62	117	491
2000	278	58	90	426
2001	233	42	131	406
2002	283	41	50	374
2003	252	35	17	304
2004	77	3	0	80
Total	1435	241	405	2081

From this data, we sought to develop a hedonic timber model which related a bid (b) on any given TSL (i) to its characteristics (x). The bid for the TSL could be an indication of the available natural resource rent associated with the timber, therefore *a priori* variables that reflected timber and site quality (*Ricardian rent*) as well as location (*von Thunen rent*) were included in x. We also included variables that reflected the derived demand for timber, the logging method, and the size of the timber sale. A detailed description of these variables and a rational for their inclusion is discussed below.

Timber and Site Quality

- Species – Each tree species has its own intrinsic properties which may affect either the selling price of downstream products derived from timber or the costs of extracting and processing timber. For this reason, the fraction of the timber sale composed of balsam (BA), western red cedar (CE), Douglas fir (DF), western hemlock (HE) and white pine (WH) were included in the model. The remaining major commercial species in the Interior (lodgepole pine and spruce), which are often marketed together, were included in the constant.
- Merchantable volume per tree (VPT) – Many higher valued sawnwood products (e.g. appearance grades etc.) are derived from larger trees. Furthermore, larger stems can be expected to improve productivity in timber extraction and processing. We anticipate that diminishing returns to tree size will occur however (indeed at some point larger trees may become a problem for some mechanized logging equipment). As a consequence, we expect bids to increase in VPT at a decreasing rate.
- Merchantable volume per hectare (VPH) – Higher density stands tend to be higher quality (less branching). They also facilitate extraction as equipment does not have to move as much to remove a unit of roundwood. Both factors lead us to believe that timber sales with higher VPH will result in higher bids.
- Fire damage (BURN) – Percent of timber sale volume with fire damage. Residual wood chips often cannot be used once timber is charred by fire and extracting and processing fire damaged timber is particularly hard on equipment, increasing costs. Therefore we expect BURN volume will reduce stumpage.
- Beetle damage (SALVAGE) – Sales that had greater than 30% of their volume infested by bark beetles were classified by the British Columbia Ministry of Forests and Range as Salvage sales. Such sales were denoted with an indicator variable (0/1) as the exact infestation percentage was not given in our data. The reduced quality (blue stain, checking etc.) associated with this infested timber is expected to negatively impact bids.
- Wind damage (BLOWDOWN) – Percent of timber sale volume which is classified as blowdown. Blowdown timber typically contains significant defect and is costly to extract, therefore its presence is expected to devalue the timber sale.
- Average Slope (%) of the terrain (SLOPE) – In general steeper slopes are expected to adversely impact the productivity of timber extraction and hence lower bids. However, the marginal impact of slope may vary throughout its range. Therefore, several functional forms will be tested.

Location

- Round trip haul time (CYCLE) – calculated using distances and road speeds from the timber sale to the nearest manufacturing centre. It also includes an hour for loading and unloading. Given that trucking contracts in the Interior are usually based on a fixed 'tonne hour' payment schedule, log transportation costs

are expected to increase linearly with cycle time.

- Region – The Interior of the province has been divided into 5 'selling price' zones by the Ministry of Forest and Range for timber appraisal purposes. Each zone corresponding to a different geographical part of the Interior. These zones and the broad geographic areas they represent are: zone 5 (North-central), zone 6 (Northwest), zone 7 (Southeast), zone 8 (Southwest), zone 9 (Northeast). Four of the zones were assigned dummy variables (zones 5, 6, 8, 9) with zone 7 being treated as a reference zone, included in the constant. Such zonal dummy variables being in place in an attempt to capture localized market conditions (competition levels, timber supply, distance to final product markets etc.).

Derived Demand

- Lumber Price Index (LPI) – This variable was constructed by taking the lumber recovery factor (LRF) of the timber sale (in thousand board feet per m^3), which proxies the marginal product of timber, and multiplying it by the prevailing lumber price at the time of the timber sale (CAN $ / thousand board feet). Through the derived demand process, increased lumber prices are expected to translate through into higher timber prices.
- Countervailing Duty (DUTY) – This is an indicator variable (0/1) which denotes those timber sales that were auctioned after countervailing duties were imposed on Canadian lumber destined to the United States (10 August 2001).

Logging Costs

- Logging Method – most timber in the Interior is clearcut and extracted by conventional ground-based equipment (feller buncher/grapple skidder). Due to terrain, soil conditions or other management objectives, alternative extraction methods and partial cutting may be prescribed though. To control for these circumstances, the fraction of the timber sale volume requiring extraction via helicopters (HELI), horses (HORSE), or cables (CABLE) were included as explanatory variables. The fraction of the sale retained after harvesting (PART_CUT) was also included to capture partial cutting applications.
- Net merchantable volume of timber sale (NCV) - This variable was included to consider any economies of scale in logging operations. As such we expect the relationship between bids and the scale of the timber sale to be positive until decreasing returns to scale set in.

After controlling for the above rent producing factors, we thought dummy variables which denote the type of sale could be included, allowing us to estimate the impact of the constraints associated with each type of sale (category 1 sales were treated as reference sales, included in the constant). Descriptive statistics for both the dependent and explanatory variables listed above are included in table 3.

Table 3. Variables in the short-term tenure model

Variable	Abbreviation	Mean	Min	Max
Bid for timber sale (1997 CAN $/m^3)	b	37.18	0.23	112.42
Fraction of timber sale composed of balsam	BA	0.08	0	1
Fraction of timber sale composed of western red cedar	CE	0.03	0	0.88
Fraction of timber sale composed of Douglas fir	DF	0.09	0	1
Fraction of timber sale composed of western hemlock	HE	0.06	0	0.98
Fraction of timber sale composed of white pine	WH	0.004	0	0.29
Lumber price index (1997 CAN $/m^3)	LPI	97.14	27.60	160.69
Percent of timber sale with fire damage	BURN	1.72	0	100
Net merchantable volume of timber sale (000 m^3)	NCV	13.09	0.01	249.69
Fraction of timber sale extracted by helicopter	HELI	0.02	0	1
Fraction of timber sale extracted by horses	HORSE	0.05	0	1
Fraction of timber sale extracted by cables	CABLE	0.07	0	1
Merchantable volume per tree (m^3)	VPT	0.53	0.08	3.45
Volume per ha (m^3)	VPH	281.31	0.30	748.02
Slope of the terrain (%)	SLOPE	20.50	0	86
Percent of volume with wind damage (%)	BLOWDOWN	3.31	0	100
The fraction of timber sale retained after harvesting	PART_CUT	0.07	0	0.99
Round trip haul time (hours)	CYCLE	4.01	1.20	12.00
Sales with more than 30% beetle damage	SALVAGE	0.22	0	1
Sales auctioned after countervailing duties	DUTY	0.50	0	1
Sales in zone 9	NORTHEAST	0.10	0	1
Sales in zone 5	NORTHCENTRAL	0.32	0	1
Sales in zone 6	NORTHWEST	0.07	0	1
Sales in zone 8	SOUTHWEST	0.13	0	1
Section 21 sales	BP	0.20	0	1
Section 20 category 2 sales	CAT2	0.12	0	1
Section 20 category 1 sales auctioned by BCTS	BCTS	0.16	0	1
Reserve price (1997 CAN $/m^3)	RP	28.68	0.22	62.52

A potential problem with our hedonic model though is the presence of 54 timber sales where no sale occurred. In these instances, no bidders were willing to pay the announced reserve price at the auction and so the bid is not observed. The exclusion of these sales could potentially result in a selectivity bias resulting in incorrect parameter estimates for the hedonic model (Huang and Buongiorno 1986, Niquidet and van Kooten 2006). Having the characteristics of these no bid sales, however, allows us to generate a Heckman model to test and correct for selectivity bias.

The Heckman model contains two equations. In addition to the bid equation, known as the outcome equation, there is a selection equation which models the occurrence of a sale. An outcome only occurs (i.e. a bid is observed) when at least one bidder's valuation

(V_i) is greater than the reservation price (RP_i). If we define d_i^* as $V_i - RP_i$, then the model can be summarized as:

[1] $d_i^* = z'_i\gamma - u_i$ selection (sale) equation
[2] $b_i^* = x'_i\beta - \varepsilon_i$ outcome (bid) equation

Where z_i is a vector containing timber sale variables that influence V_i and the RP_i (which is given), x_i is a vector of variables explaining the bid and γ and β are parameters to be estimated. With $u \sim N(0,1)$, $\varepsilon \sim N(0,\sigma)$ and $corr(u,\varepsilon) = \rho$.
Where $d_i = 1$ if $d_i^* > 0$ and 0 otherwise and $b_i = b_i^*$ if $d_i = 1$.

Therefore, the expected bid, conditional on it being observed is (Greene 2000 p. 929):

[3] $E(b_i \mid d_i^* > 0) = x'_i\beta + \rho\sigma\lambda(z'_i\gamma)$

Where $\lambda(z'_i\gamma)$ $\dfrac{\phi(z'_i\gamma)}{\Phi(z'_i\gamma)}$, with ϕ and Φ being the standard normal and cumulative normal probability distribution functions respectively. This term is known as the inverse mills ratio, its inclusion mimics the non-zero expected mean error term brought on by the selection process. If it proves to be significant in the regression, the classical regression model, where observed bids are regressed on x_i only, suffer from a missing variables problem, resulting in inconsistent parameter estimates.

The Heckman model is usually estimated in two different ways. Heckman (1979) proposed a two step procedure by way of limited information maximum likelihood (LIML). In the first step, a probit model is formed and the parameters of the selection equation (γ) are estimated by maximum likelihood. These estimates are used to construct the inverse mills ratio which is used as a regressor in the estimation of equation 3 by OLS. The two step procedure, however, has shown to be unreliable in small samples and when there are no exclusion restrictions (i.e. $x_i = z_i$) (Puhani 2001). This should not be an issue in our timber model as 2081 observations ought to be sufficiently large, and at the very least z_i will contain RP_i whereas x_i will not. Nevertheless, a full information maximum likelihood estimator (FIML), while often computationally difficult, offers a more efficient alternative to the two step estimator, and so it was chosen as our default estimation method, provided we could get convergence.

The consistency of the LIML estimator and the asymptotic efficiency of the FIML technique are both based on the assumed bivariate normality of u_i and ε_i. Pagan and Vella (1989) provide a diagnostic test for this assumption which involves including $(\hat{z}'_i\gamma)^j \lambda(z'_i\gamma)$, j = 1, 2, 3 as additional variables in the outcome equation. If the coefficients on these added variables are jointly zero, then the normality assumption can be maintained.

Longer-term tenures

In order to investigate the cost of the non-lumber capacity restrictions as well as previous tenure restrictions that focussed on employment criteria, we compiled and analyzed the auction results (lump-sum bids) for NRFLs in the Interior of British Columbia. Data on the bids for these NRFLs for the period January 2002 to July 2006 was retrieved from an independent timber price reporting agency operating in the province.[2] Seeing that the timber associated with NRFLs is only broadly specified, our dataset, in large part, contains variables that reflect the characteristics of the license, rather than the timber itself. We do not anticipate this to be a problem as the administered stumpage fee charged at the time of harvesting should capture the differential rents between stands.[3]

As a starting point we hypothesized that the lump sum bid (*BID*) on each license should represent the discounted value of the expected revenue stream accruing to the licensee over the term of the NRFL. Assuming that the annual net revenue (*R*) is simply the annual allowable cut (AAC) multiplied by the expected payment from harvesting per cubic metre (p), the expected bid for license j is given by:

$$[4]\quad BID_j = R_j\left[\frac{1-(1+r)^{-t_j}}{r}\right] = pAAC_j\left[\frac{1-(1+r)^{-t_j}}{r}\right]$$

Where t is the term of the NRFL in years and r is the discount rate. If we divide each side of equation 4 by the AAC, we can rewrite the condition as:

$$[5]\quad \frac{BID_j}{AAC_j} = p\left[\frac{1-(1+r)^{-t_j}}{r}\right]$$

In our dataset *BID, AAC* and t are all given for each NRFL. If we assume a discount rate, the term in brackets (the discount factor) can also be identified, leaving p as the only unknown. This parameter however, can be easily estimated by the following regression model:

$$[6]\quad \frac{BID_j}{AAC_j} = pd_j + v_j$$

Where d_j is the discount factor in equation 5, and v_j is a disturbance term with mean zero.

The above model is not sufficient though as we suspect the expected payment will vary according the characteristics of the NRFL. Economies of scale may be important in the management of these tenures and the various tenure conditions could prove to be overly restrictive devaluing the expected payment from the tenure. This is reflected in the following equation:

$$[7]\quad p_j = c + \omega CAP_j + \gamma PROB_j + \psi SAL_j + \delta EMPLOY_j + \theta AAC_j$$

2 http://www.woodx.com

3 The administered stumpage fee is based on an equation that contains adjustments for the timber characteristics listed in the short-term tenure model. An additional allowance is also made for the fact that long term tenure holders are responsible for some management planning and reforestation.

Where *c* is a constant term, *CAP* is a dummy variable taking the value of 1 for those tenures where bidders must create or expand non-lumber capacity and 0 otherwise, *PROB* is another dummy variable that takes the value of 1 when the tenure is restricted to problem forest types[4] and 0 otherwise, *SAL* indicates licenses where harvest units are limited to salvage sites less than 10 ha in size, *EMPLOY* indicates licenses that were awarded on the basis of price and by the degree of local employment the bidder offered, all of which were awarded prior to the FRP, and *AAC,* which was defined earlier and could take various functional forms, captures the prospective effect of scale. Descriptive statistics for the variables can be found in table 4.

Table 4. Descriptive statistics for NRFL model

Variable	Abbreviation	Mean	Std. Dev.	Min	Max
Lump sum bid (1997 CAN $)	*BID*	912 288	3 755 567	0	26 600 000
Annual allowable cut (m^3)	*AAC*	111 980	142 816	7 500	700 000
Term of license(years)	*t*	5.74	3.33	2	15
Licenses with manufacturing requirements	*CAP*	0.12	0.33	0	1
Licenses restricted to problem forest types	*PROB*	0.1	0.30	0	1
Licenses awarded by employment criteria	*EMPLOY*	0.08	0.27	0	1
Licenses restricted to salvage sites	*SAL*	0.26	0.44	0	1

Substituting equation 7 into equation 6, we obtain the final model:

$$[8]\quad \frac{BID_j}{AAC_j} = cd_j + \omega CAP_j d_j + \gamma PROB_j d_j + \psi SAL_j d_j + \delta EMPLOY_j d_j + \theta AAC_j x_j + v_j$$

The regression parameters directly yield the shadow price of the various tenure conditions. Once they are estimated, one could also extend the model to value replaceable or "evergreen" Forest Licenses, which are expected to be renewed in perpetuity. For when $t \rightarrow \infty$, equation 5 becomes:

$$[9]\quad \frac{BID}{AAC} = \frac{p}{r}$$

The valuation of replaceable Forest Licenses is especially important as they cover the greatest portion (37%) of the annual harvest in British Columbia (Berry 2006). On several occasions the government has confiscated these licenses to establish parks or in recent times to expand their auction and small tenures program. The provincial *Forest Act* however requires that the license holder be compensated for these takings. As noted by Schwindt and Globerman (1996) the lack of market evidence has made

4 Problem forest types are defined as timber stands that have a volume per tree less than $0.2m^3$

Table 5. Short-term tenure model results

	Bid Equation		Sale Equation	
Variable	Coefficent	P-value	Coefficent	P-value
CONSTANT	41.483	0.000	5.336	0.000
BA	-12.317	0.000	-1.803	0.000
CE	9.952	0.000	1.535	0.000
DF	1.549	0.160	0.256	0.082
HE	-12.716	0.000	-1.856	0.000
WH	9.100	0.370	0.960	0.478
LPI	0.168	0.000	0.023	0.000
BURN	-0.207	0.000	-0.016	0.000
NCV	0.145	0.000	0.019	0.000
NCV^2	-0.001	0.000	0.000	0.000
HELI	-38.973	0.000	-5.088	0.000
HORSE	-13.264	0.000	-1.776	0.000
CABLE	-10.160	0.000	-1.260	0.000
LN(VPT)	8.526	0.000	1.144	0.000
VPH	0.020	0.000	0.003	0.000
$SLOPE^2$	-0.002	0.000	-0.0003	0.000
BLOWDOWN	-0.124	0.000	-0.018	0.000
PART_CUT	-4.179	0.000	-0.393	0.014
CYCLE	-1.920	0.000	-0.246	0.000
SALVAGE	-3.589	0.000	-0.488	0.000
NORTHEAST	-11.895	0.000	-1.500	0.000
NORTHCENTRAL	-7.444	0.000	-1.001	0.000
NORTHWEST	-8.152	0.000	-1.036	0.000
SOUTHWEST	-3.695	0.000	-0.490	0.000
DUTY	-2.484	0.000	-0.269	0.000
YEAR_99	1.672	0.001	0.157	0.016
BP	-8.629	0.000		
CAT2	-0.817	0.140		
BCTS	0.012	0.000		
RP			-0.134	0.000
λ	7.499	0.000		
No. Observations	2081 (54 censored)			
Log Liklihood	-7004.615			
$\chi^2(28)$	5012.88	0.000		

these compensation proceedings difficult. Therefore, such modelling could be a useful input in future compensation proceedings, particularly as the sample size of transactions increases. One must use the model with caution however, as replaceable Forest Licenses may carry with them different management responsibilities and therefore might be priced differently.

Results

Short-term timber sale model

We ran several preliminary models allowing each of the explanatory variables to take on different functional forms. A linear relationship with bid in most cases fit the data best, the exceptions being NCV, VPT, and SLOPE, which took on quadratic, natural log and exponential (squared) functional forms respectively. We also searched for other variations in bids throughout time, finding that sales in the year 1999 commanded a premium.[5]

Moreover, the dummy variables denoting the type of sale were excluded from the sale (selection) equation as the no bid sales proved to consist only of category 1 timber sales. One could question the inclusion of these dummy variables on theoretical grounds as well, as there were no restrictions on re-selling timber and hence one could argue that the type of sale would have no impact on the value of the timber in question. The impact of the different sale types rather was through the bidding process; the ability to pay for the timber by other means (employment, existing capital etc.) in the case of bid proposals and reduced competition in the other cases.

Results for both the sale and bid equations stemming from this specification are listed below in table 5, estimated with FIML using *STATA*™ 9.1.

The model as a whole was highly significant, as were most variables in both equations. To confirm the consistency of our estimates, the Pagan and Vella test for normality described earlier was conducted. The coefficients and p-values associated with each of the test variables were: $(z'_i\hat{\gamma})\ \lambda\ (z'_i\hat{\gamma}) = 2.48$ (p-value 0.49); $(z'_i\hat{\gamma})^2\ \lambda\ (z'_i\hat{\gamma}) = 5.05$ (p-value 0.15); $(z'_i\hat{\gamma})^3\ \lambda\ (z'_i\hat{\gamma}) = 1.12$ (p-value 0.233). A Wald test, which tests if the coefficients are jointly zero, could not be rejected suggesting our estimates are asymptotically efficient (χ^2 3.39, p-value 0.336).

The signs on the coefficients in the sale equation all make good sense as variables that are expected to increase the value of the timber (and bid) also increased the probability of a sale, holding the reserve price constant. Likewise the negative coefficient on the reserve price indicates that increasing the reserve price decreased the probability of a sale, keeping timber value constant. The significance of the inverse mills ratio in the bid equation indicates that even with such a low degree of censoring, including the no bid data is necessary for unbiased estimates, a result consistent with Niquidet and van Kooten (2006).

The coefficient on the variable HORSE suggests that extraction with horses is $\$13.26/m^3$ more costly than conventional mechanized methods. This added cost may be justified in some cases where the achievement of a light harvesting footprint is called for. However using horse logging simply as a means of generating more employment, as was sometimes done under the SBFEP, is a rather unproductive use of resources. The same can be said for the creation of small timber sales aimed at helping small operators.

5 This might be the result of the price wedge between lumber prices in the U.S. and Canada, owed to the softwood lumber agreement, which was especially high in 1999 (Stennes and Wilson 2005). The higher bids reflecting the increased derived demand coming from those producers who had access to the higher U.S. price (i.e. quota holders).

Table 6. NRFL bid model results: dependent variable *BID/AAC*

Variable	Coefficient	P-Value
d	2.002	0.001
CAP d	-2.222	0.021
EMPLOY d	-2.135	0.054
PROB d	-0.777	0.354
SAL d	1.483	0.076
AAC^2 d	5.17×10^{-11}	0.028
No. Observations	50	
R^2	0.59	
F statistic	10.33	0.000

The coefficients on the NCV variables suggest that economies of scale are important in harvesting operations and reducing sale volume simply to provide for smaller operators has significant costs. The quadratic relationship between the bid and sale size does suggest however that there is a point where these increasing returns to scale become exhausted. We calculated this point by differentiating the bid equation with respect to NCV, finding that the optimum sale size is 101 163 m^3. Comparing bids evaluated at this optimum to the sample mean (13 090 m^3), generates a \$5.58/m^3 difference in bids.[6]

As for the influence of the various types of sales, results are as one might expect. The most restrictive timber sales, Section 21 bid proposals, received the least revenue, some \$8.63/m^3 less than section 20 timber sales auctioned to market loggers. Given that the bid proposal program represented about 7% of the provincial AAC, this result suggests that the provincial treasury can be expected to gain roughly CAN \$ 42.3 million per year, as a result of dropping this program.[7] As indicated by the coefficient on CAT2, some further revenue gains may be available by dropping the set aside program which restricts bidders on certain sales to be registered in category 2. This variable is only significant at the 14 % level however, perhaps explaining why BCTS has continued the program in spite of its new revenue focussed mandate. The positive coefficient on the BCTS indicator variable suggests that the agency has increased revenue on section 20 sales as well. This might stem from a host of timber sale related practices that have changed since BCTS has taken the helm. Perhaps the key change being the elimination of restrictions that prevented major integrated forest product manufacturers from bidding directly on section 20 sales along side independent logging firms. While statistically significant, the magnitude of the coefficient implies that using market loggers as surrogate bidders has little real impact on efficiency.

Long-term tenure model

Seeing that our long-term tenure model is dependent on the choice of an assumed discount rate, we ran the model based on several different rate assumptions (ranging

6 This analysis is based on the full latent distribution (b^*) not the truncated distribution (b). Also the coefficients used were .145 473 for NCV and -.000 719 for NCV^2 rather than the rounded numbers reported in Table 5.

7 Assuming a Provincial AAC of 70 million m^3 and that the same results in the Interior apply to the Coast.

from 4% to 20%). We also experimented with various functional forms for the variable *AAC*, finding that AAC^2 fit the data best. The 8% model was chosen based on the fact that it produced the smallest sum of squared error and the highest F-statistic. The results from this formulation are reported in table 6.

The variables *CAP d* and *EMPLOY d* proved to be negative and significant revealing that the objective of generating a non-lumber industry and the promotion of employment in the forest sector each come with their own respective price tags. The fact that the coefficient for problem forest types is not significant, suggests that in spite of the timber being of substantially lower quality, bidders anticipate that the stumpage system will adjust to reflect these quality differences. Somewhat puzzlingly, however, a higher payout is expected for salvage sites. We can only suggest that this might be due to a timber pricing expectation, as traditionally stumpage breaks are given for damaged timber and small operating units. The positive and significant coefficient associated with AAC^2, shows that economies of scale are important in the management of long-term tenures as well. This result might explain some of the recent consolidation in the Interior and why the provincial government has tended to favour the relatively larger community forests over woodlots, in the tenure re-allocation process.

Next, we calculated the expected value of a replaceable Forest License for the Interior. This was done by taking the estimated expected payment for a regular NRFL, 100,000 m^3 in size ($2.05/$m^3$) and plugging it into equation 9. Assuming that one expects the license to always be renewed in perpetuity and that it requires the same management responsibilities as those in our dataset, the value of such a Forest License is $25.63 per m^3 of AAC.

One must be cautious however, as the overall explanatory power of our model can be considered moderate (R^2 0.59). This could be due to missing relevant explanatory variables that were not available to us or because of the structure imposed on the model (constant expected payment and harvest levels per annum). Such a structure may not accurately depict reality as tenure holders do have some flexibility over when they harvest (transferring AAC from year to year within a 5 year period) and the nature of the stumpage system could mean that they expect different payments at different times in the business cycle (Grafton et al. 1996). This motivated us to seek a better fitting model allowing the relationship between the bid and *t* to take a more generalized form. We found some improvement as a log-log formulation provided some additional explanatory power, although this transformation meant dropping two observations where *BID* was zero (both of which were awarded according to employment). This model is reported in table 7.

We can essentially draw the same conclusions as the sign and significance of the explanatory variables are the same as the previous model, the exception being *SAL* which is now not significant.

Discussion

Costs or Transfers?

The results of the previous section show that the provincial government foregoes

Table 7. NRFL bid model results: dependent variable LN(*BID/AAC*)

Variable	Coefficient	P-Value
constant	-2.195	0.009
LN(*t*)	2.483	0.000
CAP	-6.033	0.000
EMPLOY	-12.791	0.000
PROB	-1.467	0.132
SAL	0.461	0.438
AAC^2	7.38×10^{-11}	0.023
No. Observations	48	
R^2	0.79	
F statistic	25.49	0.000

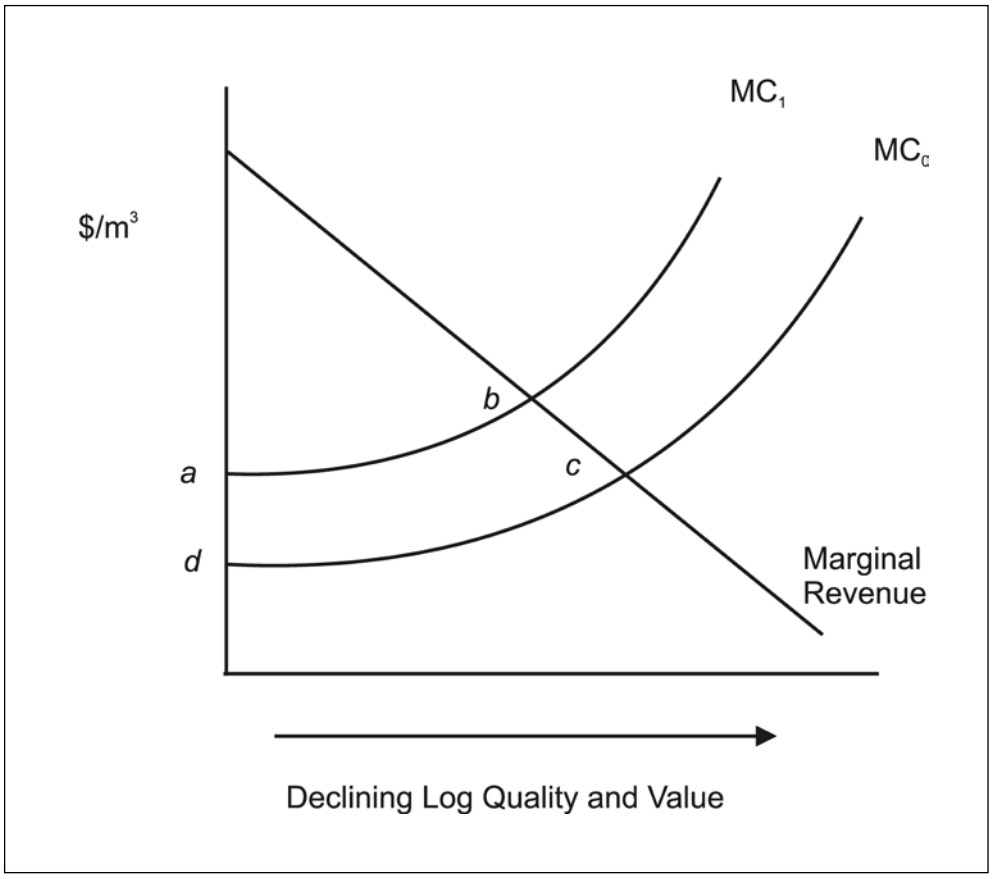
substantial amounts of revenue by imposing several of these tenure conditions. Is this an efficiency issue or a distributional issue? Should all of the revenue losses be viewed as a cost in the sense that they have reduced the overall rent available, or are they simply a transfer of resource rents from the landowner (the government) to owners of capital and labour? The answer to these questions depends to some extent on the tenure condition in question.

In cases where a timber sale could have been re-structured to reduce extraction costs (use machinery, larger timber sale) then clearly there is a loss of available rents and the lost revenue can be seen as the deadweight loss associated with re-distributing rents to smaller operators. This is shown in figure 1 as the increase in the marginal cost of extraction (MC_0 to MC_1) reduces the amount of timber utilized (Q_0 to Q_1) and the available rent by area *abcd*.

On occasions where employment and processing counted as part of the bid for timber, the answer is not as clear. It ultimately depends on whether labour and capital's claim to resource rents through the bidding process contributed to their transfer earnings - the returns required to prevent them from leaving to other uses - which are a reflection of their opportunity cost. If the shift of resource rents was indeed all surplus to the factor's transfer earnings, then these conditions should not be viewed as a cost, but simply a transfer, having no impact on efficiency. However, if the resource rents distort the employment of labour and capital, then the tenure conditions can be viewed as being costly. The cost being the opportunity cost of the factor in production elsewhere in the economy.

As alluded to earlier, since there were no restrictions on re-selling the timber to its highest valued use, or on how the timber was to be extracted, the value of the timber on the stump should not be impacted. Indeed, the common practise for those who were awarded bid proposals was to sell the timber to a major lumber producer in exchange for cash and/or supplies that were inputs to their re-manufacturing facility. The bidding process simply allowed firms to use their employees and capital as a claim towards the resource rents. If this labour and capital use would have occurred in spite of this claim, then this would just be a transfer of resource rents from the government to the firm. However, economic theory would suggest that there was a clear incentive

Figure 1. Resource rents lost from increased extraction costs



to overuse labour and capital, as their marginal value product would have increased because they now had a value in the purchase of timber. The only case where this increased demand for labour/capital would not draw in more of their use, would be if the supply of these factors was perfectly inelastic, reflecting the fact that the factor had no alternate use. This seems completely unlikely, particularly for capital, but also for labour as there has been a general shortage in labour supplies throughout the province. Although, in the short-run, it might apply to some regional labour markets where there is high unemployment and labour is very immobile.

The ultimate test then, is to see how the use of a factor changes once its claim to resource rents is taken away. If there is no change in use, then the resource rents were just a surplus value transferred from government. However, if there is now less employment of labour and capital, then resource rents were contributing to keeping the factor in its use. Recent downward trends in forest sector employment and the capacity utilization of smaller mills identified by Nelson et al. (2006) seems to suggest the latter. So does a study by Parfitt (2005) which shows the value added share of total wood exports falling by 14% between 2003 and 2004, corresponding to the end

of the bid proposal program. This suggests that there were gains to dropping the bid proposal program, as resources were freed up for production elsewhere. In addition, government resources are also likely to be saved, as bureaucrats who once spent hours grading bid proposals for their contribution to each of the criteria can now simply award timber to the bidder who is willing to pay the most, a process that is also far more transparent.

Distributional Issues

Regardless of the degree to which the increased revenue collected by government as a result of dropping these tenure conditions will be a transfer or a gain, there are distributional impacts to consider. In particular, resource rents which were once leaked in the form of wages, capital investment, or simply as excess profits to the owners of small local firms, are no longer available. In many cases this will mean a net loss of income for rural regions which are heavily dependent on the forest sector. Alternate opportunities for labour and capital will often be found elsewhere, resulting in regional decline in some cases. Such a result is often counter to a government's objective and politically unacceptable.

To deal with these distributional issues, lump sum transfers could be made to regions that are negatively impacted, helping them make the transition. This may take the form of re-training or new investment in infrastructure; these investments however should also earn their opportunity cost. The government may also think about assigning property rights over forest resources to impacted communities. This is already being done to some extent, by the increase in the issuance of community forests tenures. These tenures however should be free of unnecessary conditions and should be large enough so that economies of scale can be gained, thus not reducing the resource rent available. Moreover, the stumpage fees on these tenures could be reduced, granting the community a greater share of the available rent. The degree to which will depend on the political process. Whatever the circumstance, the rent sharing agreement should be done in a manner that does not distort resource use.

Conclusion

The goal of this paper was to highlight and quantify the costs of several socio-economic tenure conditions in British Columbia. While we feel more work in general is needed on the valuation of timber tenures in the province and in Canada (particularly long-term tenures), our results indicate most of these conditions serve to severely reduce the resource rents collected by the provincial government. In most cases, we suggest that these are more than just wealth transfers as they distort the use of capital and labour. These are real costs that should not be taken lightly in the design of forest tenures. Therefore, we conclude that dropping several of these conditions has been a tremendous benefit to the province and a gain in economic efficiency. While we realize that distributional impacts are likely to be important considerations, effort

should be made to design policy such that these distributional goals are met in a manner that is not so costly.

References

Berry, A. 2006. Lessons from British Columbia: public forest management. Property and Research Center, Land Report [online]. Available from http://www.perc.org/pdf/pl5.pdf [accessed 25 January 2007]

British Columbia Ministry of Forests and Range. 2006. Policy 14.1: SBFEP Bid Proposal Program, Timber Sale Licences, Forest Act, s.21 [online]. Available from http://www.for.gov.bc.ca/tasb/manuals/policy/resmngmt/rm14-1.htm [accessed 10 May 2006]

British Columbia Timber Sales. 2006. Frequently asked questions: manadate and strategic direction [online]. Available from http://www.for.gov.bc.ca/bcts/faq/index.html#Mandate [accessed 14 June 2006]

Cashore, B., Hoberg, G., Howlett, M., Rayner, J., Wilson, J. 2001. In search of sustainability: British Columbia Forest Policy in the 1990s. UBC Press, Vancouver, B.C.

Grafton, R.Q., Lynch, R.W., and Nelson, H.W. 1998. British Columbia's stumpage system: economic and trade policy implications. Can. Public Policy. **24**(Supple.2): S41-S50

Greene, W.H. 2000. Econometric analysis. 4th edition. Prentice-Hall Inc., Upper Saddle River, New Jersey.

Heckman, J.J. 1979. Sample selection bias as a specification error. Econometrica. **47**: 153-161.

Huang, F.M. and Buongiorno, J. 1986. Market value of timber when some offerings are not sold: implications for appraisal and demand analysis. For. Sci. **32**: 845-854.

Luckert M.K. and Haley, D. 1990. The implications of various silvicultural funding arrangements for privately managed public forest land in Canada. New Forest. **4**: 1-12.

M'Gonigle, R.M., and Parfitt, B. 1994. Forestopia: A practical guide to the new forest economy. Harbour, Madeira Park, Canada.

Nelson, H. Niquidet, K and Vertinsky, I. 2006. Assessing the Socio-economic impact of tenure changes in British Columbia. BC forum on Forest Economics and Policy Synthesis Paper: SP 06-02. Available from http://www.bc-forum.org/_media/SP0602tenuresocio-economicimpacts.pdf [accessed 22 January 2007]

Niquidet, K., and van Kooten, G.C. 2006. Transaction evidence appraisal: competition in British Columbia's stumpage markets. For. Sci. **52**: 451-459.

Pagan, A., and Vella, F. 1989. Diagnostic tests for models based on individual data: A survey. Journal of Applied Econometrics. **4(4)**: S29-S59.

Parfitt, B. 2005. Getting more from our forests: ten proposals for building stability in BC's forestry communities. A report prepared for the Canadian centre for policy alternatives. December 2005. Available from http://www.policyalternatives.ca/documents/BC_Office_Pubs/bc_2005/public_forests.pdf [accessed 15 August 2006].

Pearse, P.H., 1976. Timber rights and forest policy in British Columbia: Report of the royal commission on forest resources. Queen's Printer, Victoria.

Puhani, P.A., 2001. The heckman correction for sample selection and its critique. Journal of Economic Surveys. **14**: 53-68.

Scwindt, R., Globerman, S., 1996. Takings of private rights to public natural resources: a policy analysis. Can. Public Policy. **22**: 205-224.

van Kooten, G.C. and Folmer, H. 2004. Land and forest economics. Edward Elgar, Cheltenham, U.K.

Zhang, D., 1996. Forest tenure and land value in British Columbia. J. For. Econ. **2**: 7-30.

Zhang, D., Pearse P.H., 1996. Differences in silvicultural investment under various types of forest tenure in British Columbia. For. Sci. **42**: 1-8.

Zhang, D., Pearse P.H., 1997. The influence of the form of tenure on reforestation in British Columbia. For. Ecol. Manage. **98**: 239-250.

VI. Using hedonic stumpage models as a management tool in British Columbia

This chapter is based on Niquidet, K. 2007. Using hedonic stumpage models as a management tool in British Columbia. In Review with *The Forestry Chronicle.*

Abstract

In this paper, a hedonic stumpage model is used to assess harvest timing and silviculture investment on a range of sites throughout the interior of British Columbia. It is also used to develop the rent gradient over these lands. Results indicate that much of the bare land in this region is outside of the extensive margin for the purposes of establishing private timber plantations. This may help to explain why, in general, private property rights have developed for existing timber stocks, but not for land. Furthermore, on these marginal lands, rent dissipation as a result of sustained yield management is significantly smaller than lands with higher productivity.

Introduction

The value of standing timber, commonly known as stumpage, is derived from the value of downstream forest products such as logs or lumber. To reflect this, the appraisal of timber was commonly done by a residual value approach. On the surface, the application of the residual value method appears to be a relatively simple accounting exercise, as an appraiser calculates the selling price of the downstream product and subtracts the costs of converting the timber into this product, including some allowance for profit and risk. In practise, such calculations were plagued with complexity. Timber can yield a host of products and grades; as a result its selling price is highly dependent upon the species, size and quality of the timber in question. Equally variable, are the costs of extracting and processing timber, sensitive to several site specific variables.

In many cases the information required for an accurate residual value appraisal was not (widely) known or was costly to acquire. This meant that significant resources were being spent on the appraisal process or accuracy was sacrificed by using broad averages which did not account for individual operating circumstances. In response to the information problems, transaction evidence appraisal (TEA) techniques have become popular (Schuster and Niccolucci 1990). TEA methods simply use data on previous timber sales to assess the likely value of another stand of timber. As discussed above, the sale price of timber will vary substantially according to individual stand specifics which affect either the selling price of the downstream product or the extraction and conversion costs. However, hedonic techniques can be adopted into the TEA framework to explain most of this variation. The great benefit of a hedonic stumpage model, therefore, is their

ability to reveal the impact of marginal timber characteristic changes on stumpage value. These shadow prices create a stumpage equation that allows for quick, accurate appraisal of a wide range of timber stands.

To date these models have been used by forest managers, particularly on public forestland, to set appropriate reservation prices in the auctioning of timber. In an academic setting, hedonic stumpage models have been used extensively to investigate such things as auction design (Hansen 1985), timber sale competition (Brannmann 1996) and the management of biodiversity (Boltz et al. 2002). Nonetheless, in all cases that I am aware of, the hedonic models were applied to assess timber value at a given point in time. As a consequence of biological growth or decay, many of the timber characteristics used in the hedonic model vary through time. Furthermore, these physical characteristics can often be shaped by timber stand improvement activities. All of this suggests that these models could be applied as a management tool in determining the optimum timing of harvest, weighing the costs and benefits of silviculture investments, and in the identification of economic margins for forestland. Using examples from the interior of British Columbia (BC) this paper illustrates how hedonic models can be very useful for these purposes.

The organization of the paper is as follows: in the next section I briefly review the workings of hedonic stumpage models and introduce the model which will be applied in the BC situation. Following this, the next section outlines the methodology taken to 1) calculate the optimum rotation age 2) assess the merits of common silvilculture techniques and 3) determine the extensive margin of forestland. This methodology is then applied to BC's dominant commercial tree species, lodgepole pine (*Pinus contorta* Dougl.) across a range of site types. These results are then discussed in relation to current institutional arrangements governing timber use and investment in the province. My conclusions follow.

Hedonic Stumpage Models

The relationship between various timber stand characteristics and its value has been studied extensively. An early study conducted by Guttenberg (1956) however had most of the necessary characteristics. In his study, variables such as volume sold, volume per acre, timber quality, timber species and lumber price all proved to influence stumpage value.

As expected, the significance and sign of these variables are consistent with the residual value method of appraisal: as a result of economies of scale in timber harvesting, larger volumes sold reduce extraction costs leading to higher stumpage values; lower volumes per area have a negative impact on stumpage due to the reduced productivity associated with the need to move equipment more often to extract a unit of roundwood; timber quality, measured by the size and shape of the tree as well as by things like the presence of pest damage, impact stumpage from its influence on both the selling prices of downstream products (e.g. larger straighter trees allowing for more lumber recovery

per unit of roundwood and the production of veneer logs) as well as on processing and extraction costs (e.g. smaller trees with defects caused by decay or pest damage decrease productivity because more felling and bucking needs to be done per unit of roundwood); timber species driving stumpage according to its own intrinsic wood properties (structural or appearance); and finally lumber price (i.e. sawnwood price) shaping stumpage through a derived demand process.

The location of the stand will also be important. Timber is a bulky good that is costly to transport (Yin et al. 2002). Consequently, the distance to the log market is bound to have a significant impact on stumpage. Further, the slope of the land upon which the timber sits will determine the extraction methods employed (e.g. cable vs. ground based) and the productivity of those methods.

Many studies have confirmed the importance of the variables listed above and typical hedonic studies of recent vintage use such timber characteristics as a control to investigate institutional and informational timber sale characteristics. For example, Dunn and Dubois (1999) examined contractual stipulations contained in timber sales, finding that higher performance bonds reduced bids for stumpage and Munn and Rucker (1994) found that information provided by a consultant at a private timber sale could positively increase bids.

Another example of such a study is that of Niquidet and van Kooten (2006). The main purpose of their paper was to investigate the impact of regional competition levels on the bids for standing timber throughout the interior of British Columbia. Their model however, also affirms the associations found by Guttenberg and several other studies. It suggests that the value of a stand of lodgepole pine timber in the southern interior region of the province is equal to the following equation:[1]

[1] $B = 20.136 + 0.287\ LPI + 0.368\ SLOPE - 0.011\ SLOPE^2 - 2.382\ HAUL + 0.003\ VPH + 2.109\ LN(VOL) + 10.729\ LN(VPT)$

Adjusted $R^2 = 0.78$, Log-Likelihood ratio = 363.87

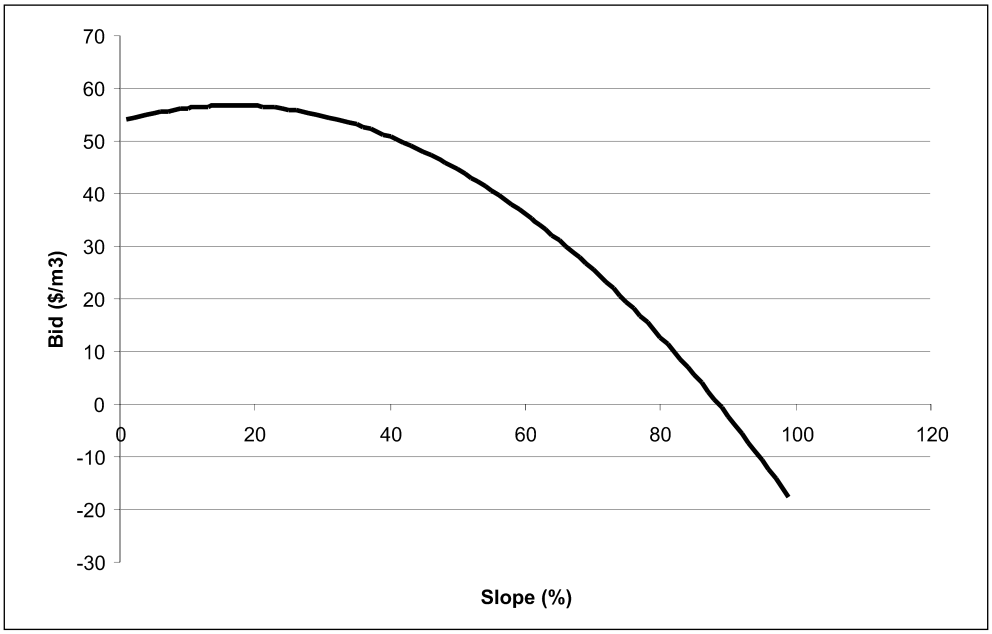
Where B is the bid for stumpage in \$ per m^3;[2] LPI is a lumber price index also in \$ per m^3 (found by taking the lumber price at the time of the sale in \$/thousand board feet and multiplying it by the lumber recovery factor (LRF) of the timber stand in thousand board feet/m^3); SLOPE is the average slope of the terrain; HAUL is the round trip trucking time in hours to haul logs from the timber sale to the nearest manufacturing center (it also include includes 1 hour for loading and unloading); VPH is the merchantable timber volume per hectare; LN(VOL) is the natural logarithm of the total merchantable volume in the timber sale; and LN(VPT) is the natural logarithm of the net merchantable volume in the stand per tree, also known as "piece size".

1 Based on reduced form bid equation estimated by truncated regression. Lodgepole pine was a reference species contained in the constant. This equation also assumes that : 1) logging system does not use helicopters or horses; 2) the stand has not incurred fire, beetle or blowdown damage; 3) the road network is already established; and 4) free trade in lumber between the United States and Canada.

2 All dollars in this paper are in 1997 \$CAN

The quadratic relationship between slope and stumpage at first glance may seem a bit puzzling, as over some part of its range slope actually increases bids. This relationship is shown explicitly in figure 1 below, evaluated at the means for the other variables, as reported in Niquidet and van Kooten (2006).

Figure 1. The relationship between slope and the bid for timber in the interior.



This relationship is actually quite logical given the extraction methods currently employed in the interior. Typically, sites in the interior with slopes between zero and forty percent are felled with mechanized equipment and the trees are skidded to a road by wheel based equipment. Loggers attempt to locate roads in a manner where they can, for the most part, skid trees downhill. Having some slope therefore can actual facilitate skidding because it results in less resistance as the trees are dragged over the ground. This probably explains why for the range between zero and seventeen percent bids actually increase with increasing slope. After this point, the steeper slopes start to slow the equipment down as they make their way back up the hill to get more trees, reducing productivity. Productivity then starts to rapidly decline on slopes over forty percent as it becomes too dangerous to use wheel based equipment for skidding and slower moving track based equipment or cable systems must be used. The steeper slopes also increase felling costs as a point is reached where feller bunchers can not safely or productively work on the terrain, meaning labour intensive hand falling with chainsaws will be necessary. Slope however is a static variable.

As a result of biological growth, for a given timber tract VPH, VOL and VPT all change through time. To reflect this, each of these variables along with B should be denoted as being a function of time (t). Exactly how the variables change with t or with

different management activities can usually be readily recovered from a variety of growth and yield models. An example of such a model, that is publicly available, is the BC government's TIPSY 3.2b program (BC Ministry of Forests and Range 2006). TIPSY allows users to model growth and yield for a collection of tree species on a range of sites that vary according to their productivity.[3] It also will model several stand management regimes such as thinning and fertilization, as well as yield increases associated with using genetically improved seedlings. TIPSY also contains an algorithm which relates the size and shape of the trees in the stand to their LRF. Combining this with the lumber price, gives the stand's LPI.[4] Once these variables are established, stumpage can be modelled through time for a site with a given slope and distance to market. Such information could be very valuable for timber supply modelling at both the stand and landscape levels.

Applications

Optimum Rotation

Following Faustmann's original work in 1849 on the optimum rotation in forestry, vast literature has been produced on the subject. Indeed, Newman (2002) documented some 313 published works on the subject. While this literature has proved to be significant, incorporating things like non-market amenities (Hartman 1976), uncertain prices (Norstrom 1975) and stochastic growth (Buongiorno 2001), the basic framework provided by Faustmann has stood the test of time. Faustmann's approach rests on the idea of soil rent, also commonly referred to as the "land expectation value" or "soil expectation value". The soil rent (*V*) of a hectare of land is simply the net present value of a perpetual harvest of timber every *t* years. Starting with bare land, the formula for the soil rent of the land is: (Pearse 1990)

$$[2] \quad V(t) = \frac{S(t) - c(1+r)^t}{(1+r)^t - 1}$$

Where $S(t)$ is the stumpage value in dollars per ha at the time of harvest, which in the BC interior case would be equal to $B(t)$ x VPH(t), c is the cost of establishing trees and r is the discount rate.

The optimum rotation age (t^*) according to Faustmann is that which maximizes the soil rent of the land. Accordingly, the maximum soil rent also identifies the most

3 Technically speaking TIPSY is not a growth and yield model, it retrieves growth and yield information from a series of tables generated by the growth and yield model TASS (Tree And Stand Simulator). Indeed TIPSY is an acronym for Table Interpolation Program for Stand Yield. See Lucca 1999 for more details.

4 Consistent with the approach of Faustmann a deterministic price is used in this paper. A mean reverting or random walk stochastic process could be also adopted for lumber price (see for example Brazee and Mendelsohn 1988; Gjolberg and Guttormsen 2002). In principle one could also incorporate stochastic growth and yield (Buongiorno 2001).

one would be willing to pay for the land, something that will be important later in the discussion about the demand for property rights over forestland. Pearse (1990) also shows that the Faustmann rotation age is equivalent to the time where the marginal benefit of delaying the harvest is equal to the cost of waiting. This can be shown as:

$$[3] \quad \frac{S'(t)}{S(t)-c} = \frac{r}{1-(1+r)^{-t}}$$

Where the left hand side of the equation represents the percentage growth rate of the value of the current stand and the right hand side reflects the opportunity cost of both capital and land. Thinking of the rotation problem in this way may be more tractable for stands that are already established, as would be the case for much of the forestland in Canada where forests have been put their by nature.[5]

Further characterizing much of the Canadian forest is its low productivity and limited accessibility (Benson 1988). So much so that the opportunity cost of the land, for the purposes of growing timber, in many cases could be zero. This would occur when the soil rent as represented by equation 2, is less than or equal to zero. In that case, the optimum time to harvest an existing stand of timber, assuming basic reforestation was a requirement after harvesting, could be simplified to (Pearse 1990):

$$[4] \quad \frac{S'(t)}{S(t)-c} = r$$

This rotation rule yields what is known as the Fisher rotation, the rotation that maximizes the present value of a single harvest (van Kooten and Folmer 2004).

Given that the opportunity cost of the land for growing timber is zero, the harvest decision is unaffected if rights to only the existing stock of timber are given (and not further rotations). Of course under such a situation there actually would be no incentive for the rights holder (whether they had rights to the stock only or both the stock and the land) to replant and incur *c*. Without regulation, therefore, equation 4 would not contain *c*. Nevertheless, in practise, for many jurisdictions, British Columbia included, reforestation is mandatory on the basis of sustainability and non-timber benefits. For some species and sites however, the forest will regenerate naturally in a relatively short time period. In those cases, reforestation regulations could actually be met without incurring *c* as well.

Silviculture Investment

Establishing trees on bare land is an investment that can be easily assessed by use of equation 2. If the maximum soil rent for growing trees is positive, then planting will occur. Once a stand is established however, further investments can be made to shape the development of the stand and increase its growth and yield. Keeping with the

5 According to the FAO (2000) only 6.8 million ha out of Canada's 245 million ha forest estate could be considered as plantations. http://www.fao.org/DOCREP/003/X8423E/X8423E00.htm#TopOfPage

terminology used in British Columbia, in this paper I will refer to stand establishment as "basic" silviculture and additional stand investments as "enhanced" or "intensive" silviculture. Enhanced silviculture could include such activities as pruning, pre-commercial or commercial thinning, as well as fertilization.

To assess the merit of these enhanced silviculture activities one would need to adapt equation 2 to incorporate the cost of the enhance treatment (E) in year y as follows:

$$[5] \quad V(t) = \frac{S(t) - c(1+r)^t - E(1+r)^{t-y}}{(1+r)^t - 1}$$

In spite of the additional cost incurred in year y, the value of the land may increase because the activity will provide benefits at the time of harvesting. These benefits may be the creation of larger tree stems (increased VPT) or simply higher yields (increased VPH). To perform a cost benefit analysis one would therefore compare the value of the land under this enhanced management regime to the value of the land under the basic silviculture regime. If the enhanced management regime increases the value of the land, then it is worthwhile and one would proceed with the activity. If it does not then the basic regime will prevail.

Land Use and Timber Supply Modelling

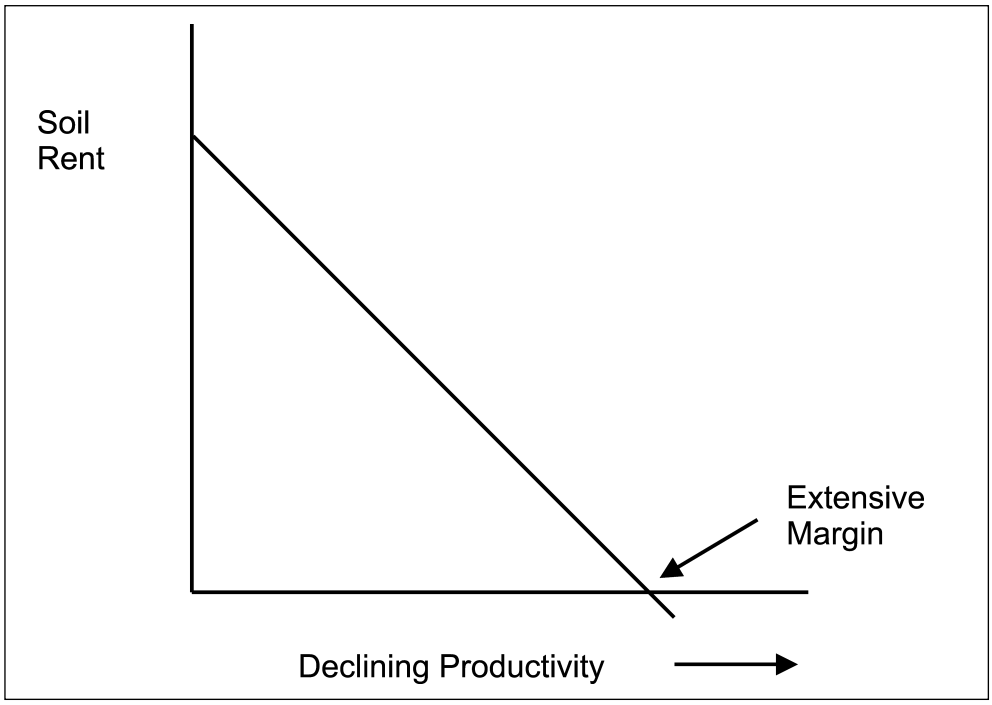
The soil rent of land for the purposes of growing trees will largely depend on two things. The first being the productivity of the site (Riccardian rent) and the second being the location of the land (von Thunen rent). All else equal, a less productive site will yield lower volumes per hectare and per tree, leading to lower stumpage values and lower soil rent. Therefore, as the productivity of land becomes poorer, eventually a point will be reached where the soil rent becomes zero, a point known as the extensive margin. This is shown in figure 2.

Figure 2 could have also been re-drawn with reference to location, as haul time or slope would replace productivity on the x axis. Finding the extensive margin in these cases simply involves setting the maximum V equal to zero by changing haul time or slope.

When operating commercially in over mature forests - as is the case for virtually the entire interior - the extensive margin takes on a slightly different meaning however. Harvesting this timber earns, what has been termed by Luckert and Bernard (1993), stock rent. This refers to the fact that the stock of timber being harvested has been supplied naturally, without anyone having to incur the cost of establishing the stand or the cost of time. Assuming it is optimum to harvest immediately, the value of this stock rent is simply the stumpage value of the mature timber, which again can be established by equation 1. As a consequence, foresters in British Columbia tend to refer to the extensive margin as the mature stand that earns zero stock rent. This extensive margin can differ greatly from the extensive margin described in figure 2.

If the land base is blanketed in mature timber, the maximum one will be willing to pay for the land is the sum of the stock rent and the soil rent. It could be the case however, that stock rents are positive on a site, while soil rents are zero or negative. This situation

Figure 2. The extensive margin of forest land.

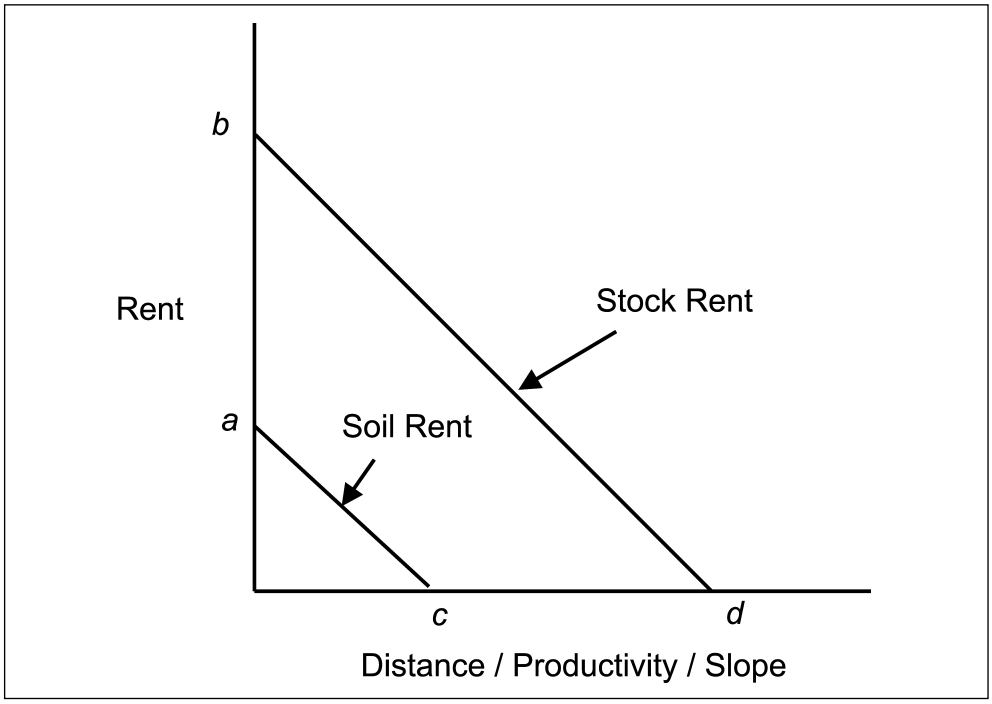


is shown in figure 3, as in the range between the two extensive margins, point *c* to *d*, the demand for property rights over the land is solely based on the existing stock of timber, not the intrinsic productivity of the land. It is on these sites that one could expect to find property rights for timber but not for land (i.e. timber harvesting concessions or tenures). Furthermore, seeing that there is no private incentive to reforest these sites, other policy instruments will be needed to prevent deforestation, except in cases where natural regeneration is prevalent. In addition, the low stock rents on these sites may not cover the opportunity cost of the non-timber benefits forgone by harvesting, it is on this part of the landscape therefore where sustainability issues and land use conflicts are most likely to occur.

In British Columbia, most of the forest is owned by the public and managed under a regulated sustained yield (SY), even flow harvest regime. This regime entails drawing the stock of mature timber down in a constant manner over a rotation, subject to the growth of the immature stock, in the pursuit of a balanced age class structure (i.e. a normal forest). With SY, timber supply is based almost exclusively on physical criteria as the rotation age used in supply determination is that which maximizes the mean annual increment of the forest. In fact, the only economic input in the process is the identification of *d*, which is termed the timber harvesting land base (THLB) in British Columbia.

Operating under the SY paradigm the chief forester sets the annual allowable cut (AAC) based on an assumed THLB, which is loosely defined by some critical VPH or slope threshold. A study conducted by Williams and Gasson (1986) however has

Figure 3. The extensive margins associated with soil and stock rents.



shown that the THLB can be grossly miscalculated. Although, I would prefer that more economic variables be considered in timber supply analysis, for the purpose of conducting SY timber supply analyses in Canada, employing hedonic stumpage equations could also be very useful. Within GIS and timber supply software, the forested landscape could be divided into operational timber stands (polygons) according to like physical characteristics (age classes etc.) and operational constraints (e.g. maximum harvest unit sizes). Plugging the timber inventory data from each timber stand into the hedonic equation thus would allow one to map a site specific accurate THLB.[6]

Results

Faustmann rotation

Yield information was created from TIPSY for lodgepole pine planted at 1200 stems per ha on four sites which differed according to their productivity class. These productivity classes are very good (SI_{50} 25), good (SI_{50} 20), medium (SI_{50} 15) and poor (SI_{50} 10). An operational adjustment factor was also applied which reduced yield by

6 This assumes that the timber inventory data is sufficiently detailed to complete the hedonic equation. In discussions with the BC Ministry of Forests and Range, it appears that the current landscape level timber inventory data does not contain all the necessary variables for equation 1.

ten percent to account for anticipated stocking gaps associated with small unproductive micro-sites. For each site, the yield information was then exported to a spreadsheet where stumpage per ha was calculated throughout time by use of equation 1. This calculation was based on a lumber price of $385 per thousand board feet,[7] for a logging unit with a slope of 20 percent, 40 ha in size, with a cycle time of 3 hours. Planting costs of $470.13 per ha were derived for this regime based on a cost function reported in TIPSY, which is based on BC Ministry of Forests and Range data. Soil rents were then calculated using real discount rates of 3% and 7%, reflecting the likely discount rates employed in forest management by the public and private sectors respectively (Heaps and Pratt 1989). The optimum rotation ages, as well as the corresponding soil rents and some of the timber characteristics at rotation are reported below in table 1.

Table 1. Faustmann management in the BC interior

Productivity	Poor		Medium		Good		Very Good	
Discount Rate	3%	7%	3%	7%	3%	7%	3%	7%
Faustmann Rotation Age	98	81	67	54	52	42	43	35
Soil Rent ($/ha)	-276	-463	686	-366	2770	-34	6253	668
VPT at rotation (m^3)	0.12	0.08	0.19	0.13	0.26	0.19	0.35	0.25
VPH at rotation (m^3)	112	78	180	123	250	177	326	238

As expected, the discount rate has a large impact on the timing of harvesting and on the soil rents generated by the land. In fact, only the very good site earns positive soil rents using a private sector discount rate (7%).

Pre-commercial thinning

For this very good site, the feasibility of a pre-commercial thinning enhanced management regime was then analyzed. This management regime has been applied in varying degrees in the past through provincially funded programs such as Forest Renewal BC and through the federal-provincial cost shared Forest Resources Development Agreement, commonly known as FRDA. The stand was thinned down to 600 stems per ha when it reached a top height of 4 meters which corresponded to about age 9. The cost of this treatment being $ 496.07 per ha, which again was obtained from a cost function provided in TIPSY, derived earlier from Ministry of Forests and Range data. Results are provided in table 2.

Table 2. Pre-commercial thinning regime on a very good site.

Discount Rate	3%	7%
Faustmann Rotation Age	45	35
Soil Rent ($/ha)	4758.19	174.65
VPT at rotation (m^3)	0.53	0.35
VPH at rotation (m^3)	271	180

7 This price reflects the quarterly average price for spruce/pine lumber in the interior for the period 1996 to 2004.

The optimum rotation age for the thinning regime is 45 years when using a discount rate of 3 percent and 35 years with a discount rate of 7 percent. The thinning proved to increase the size of the trees substantially, as VPT at the time of harvest jumped to 0.53 m^3 and 0.35 m^3 under the respective discount rate scenarios. This increased the expected bid per cubic metre but also significantly reduced the VPH, having the effect of actually reducing the stumpage per ha at the time of harvest. The reduced harvest value plus the cost of the treatment serves to severely reduce soil rents, falling to $4758.19 per ha under the 3 percent discount rate scenario and $174.64 per ha under the 7 percent scenario. Such an investment would clearly be unacceptable from an economic perspective. Given that there are almost limitless potential tree growing regimes (i.e. different initial and post thinning stocking levels) this should not be taken to suggest that there is no role for pre-commercial thinning in British Columbia. It does however illustrate that the hedonic method can be easily used by forest managers to assess the tradeoffs associated with the several potential regimes.

Extensive margins

The results listed in table 1 are for a site with a round trip haul time of 3 hours, which in a Canadian context is relatively close to the log market. The extensive margin of these sites was then calculated by setting the maximum soil rent equal to zero by changing the haul time; this was carried out by the solver tool in Microsoft Excel. The results, listed in table 3, suggest that the private market using a discount rate of 7% would not establish trees on any poor to medium sites regardless of their proximity to the market and would only demand bare land for forestry purposes on good sites within 1.71 hours of the market and on very good sites 14.9 hours from the market. This appears to be a very small part of the interior forest estate as according to British Columbia Ministry of Forests and Range data, shown in table 4, only about 12% of the interior THLB can be considered good or better (most of which is concentrated in the Southeast region).[8] This also contrasts significantly with the state operating under a public sector discount rate of 3%. Under this scenario it is still not worth it to establish trees on poor sites but tree growing on medium, good and very good sites are viable on a vast stretch of land.

Table 3. The extensive margin for different classes of land in the BC interior

Productivity	Poor		Medium		Good		Very Good	
Discount Rate	3%	7%	3%	7%	3%	7%	3%	7%
Extensive Margin (hours)	-	-	13.60	-	22.00	1.71	28.00	14.90

8 Perhaps not surprisingly the Southeast contains the only significant parcels of private timberland in the interior. Comparable data was not available for the Fort Nelson and Peace Forest Districts (both located in Northeast BC) so they were excluded from the Northern Interior.

Table 4. The productivity of the BC interior timber harvesting landbase

Site Index (breast height age 50)	Northern Interior[a] (hectares)	Central Interior[b] (hectares)	Southwest Interior[c] (hectares)	Southeast Interior[d] (hectares)	Total (hectares)
< 15 m	3,255,921	2,129,620	1,231,879	165,000	6,782,420
15 - 20 m	3,583,485	1,336,975	2,248,188	433,139	7,601,787
> 20 m	461,296	189,898	275,202	1,071,401	1,997,797
Total	7,300,701	3,656,493	3,755,269	1,669,540	16,382,004

[a] Includes all of the Northern Interior Forest Region except the Peace and Ft. Nelson Forest Districts
[b] Includes the Quesnel, Chilcotin, Central Cariboo and 100 Mile Forest Districts
[c] Includes the Columbia, Okanagan, Kamloops, Cascades and Headwaters Forest Districts
[d] Includes the Rocky Mountain, Arrow-Boundary and Kootenay Lake Forest Districts

Now consider the same land base but naturally stocked with mature timber, 300 m^3 per ha, with a VPT of 0.5 m^3, and a LRF of 250 board feet per m^3, roughly the average stand currently being harvested in the BC interior. Unlike the rents for the soil, this stock rent is considerable and the demand for it extends far across the landscape, as the extensive margin in this case is 28.6 hours away from the market centre.

Discussion

Property rights and Silviculture

The results in this paper seem to call into question the empirical findings of previous studies which showed that greater silviculture expenditure in British Columbia will occur on private land where owners can reap the reward of their investment (Luckert and Haley 1990; Zhang and Pearse 1996). What might explain this contradiction?

It is difficult to say for sure without further research. However, I would suggest it could be due to two reasons. Firstly, in both instances the private land surveyed was part of a management unit managed under SY.[9] As a result, higher expenditures could be the result of the allowable cut effect where silviculture is undertaken simply because it lessens the constraints put in place by SY on how quickly the stock of mature timber can be liquidated (Schweitzer et al. 1972; van Kooten and Folmer 2004). Put another way, silviculture is taking place on the basis of stock rents not soil rents. This differs from the analysis in this study where the stand alone benefits of silviculture were assessed. It is not clear if such expenditure would be undertaken if the investment had to hold up on its own.

Secondly, and probably more importantly, is the location and productivity of the private land sampled by these studies. Private forestland in British Columbia exists

9 In the case of Luckert and Haley (1990) the private land was a 'Taxation Tree Farm' where the owner committed to SY. This land often was also part of a larger public management unit called a Tree Farm License managed collectively under SY. In the case of Zhang and Pearse (1996) all of the private land was part of a Tree Farm License managed by SY.

primarily on the east side of Vancouver Island. This land is relatively flat compared to other parts of the coast, is close to processing facilities and offers growth rates that do not exist in the rest of Canada. While Zhang and Pearse's model does attempt to control for location and site quality, they do not appear to have adequately sampled private lands. For their sample statistics (table 3 in their article) reveal that virtually no private land was included outside of the coastal forest region.[10] Of course this is probably an artefact of the data which was available to them, as few larger industrial private forestland holdings exist in the interior.

Ultimately then, this raises the possibility outlined by Bromley (1991), that property rights have been endogenously determined, explained by the "inherent nature of the land, through the rent gradient". By failing to recognize this endogeneity however, these studies are potentially subject to Bromley's critique; erroneously suggesting that causality runs the other way, with the property rights regime explaining the rent and investment in the land. While their results may hold true for forestland on the coast in a similar location with comparable productivity, this study suggests they should not be broadly applied across the interior of the province as, for the most part, the private sector would not establish trees at all. Furthermore, given that the productivity of the forested estate in the rest of the country is more akin to the interior, one should be cautious about transferring their results to other parts of Canada, particularly the slow growing boreal forest which dominates Canada's North.

Existing institutions and institutional change

The above results therefore also seem to shed some light on the existing timber institutions in British Columbia and probably the rest of Canada, where over ninety percent of the land is publicly owned and rights to harvest mature stocks of standing timber are granted to private companies. This is not to say that existing institutions are efficient, rather than managing the forest under Faustmann's rule, the provinces regulate timber harvests according to SY policies which as mentioned earlier entails drawing the existing stock of mature timber down in a constant manner over a rotation and harvesting immature stocks once they reach the age that maximizes mean annual increment.

Alston et al. (1996) suggest that demand for institutional change comes from the difference between the potential rents generated under a competing regime with that of the status quo. Seeing that the SY policy effectively involves two policy choices (how quickly to liquidate existing over mature stocks and what rotation age to manage new crops) which involve stock and soil rents respectively, in analyzing rent differentials and the demand for change, it will be useful to distinguish between the two.

In terms of the former - the liquidation of the mature stocks - establishing an alternate policy or property rights regime in which to compare to SY will be complicated by at

10 98% of the private land sampled was from the coast.

least three things. First, seeing that British Columbia can be considered a large player in the North American timber market, where demand has been shown to be inelastic (van Kooten 2002), alternate rates of harvest will likely have price effects. Indeed, a potential advantage of public ownership that is frequently not mentioned is that it affords the province the ability to set harvest quotas with reference to their impact on North American lumber prices (*Ibid*). Secondly, some of the existing mature timber may contain traits which are not available from second growth stands, as such this timber can be thought of as a non-renewable resource, generating scarcity rent as it is depleted.[11] Lastly, several non-market amenities can be attributed to the mature stock. Any rent dissipation could be justified on the basis of providing these non-timber products. Such a complex analysis is well beyond the scope of this paper.

In terms of the latter, it is trivial to suggest that SY dissipates rents as by definition the Faustmann rotation age maximizes soil rent. However, in the BC interior case, on lower quality sites further from the market centre, the demand for institutional change may not be all that great. Figure 4 shows the rent dissipation associated with SY for the different classes of land defined earlier as distance to market increases.

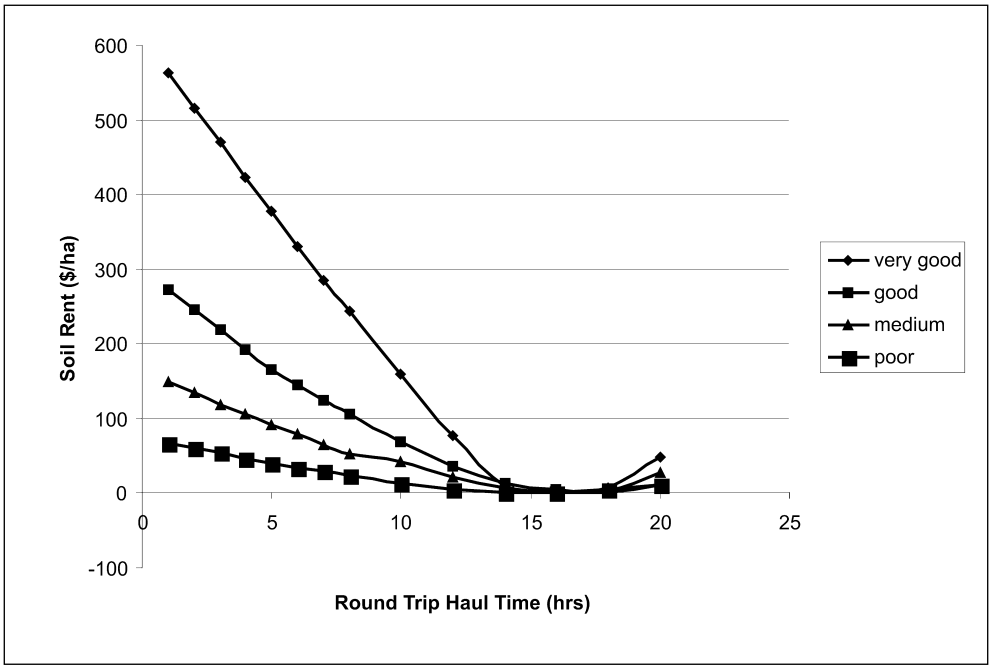
As the productivity of the land increases or the distance to market centre decreases, the amount of soil rent that the SY policy dissipates increases. As a consequence one can expect that pressure for change will be largest on the very good sites close to processing facilities. The demand for change on lands that are not very productive and further from the market centre may not be enough to break from the status quo however. Particularly once one considers the non-timber benefits which are produced from the longer SY rotation.[12] For instance, van Kooten et al. (1995) found that if one considers the role forests play in carbon sequestration, rotation ages would typically be slightly longer than the Faustmann age. Growing timber on a longer rotation is also frequently beneficial to several species of wildlife and older stands are generally preferred for recreational purposes. These values are often hard to quantify however. For practical purposes though, the SY rule may be suitable and even relatively more efficient than Faustmann management on much of the poor and medium sites and on good and very good sites far from the market.

In summary, outright privatization of either the land or the stock of mature timber will not necessarily be more efficient. Institutional reform, which grants the private sector greater control over these resources, must be cognizant of the incentives the private sector faces. On land that is highly productive such that the private sector has the incentive

11 This will depend on the species in question, its age and the availability of substitute products. Given the history of fire disturbance much of the mature stock in the BC interior is between 80 to 140 years old. The timber coming from such stands, particularly pine and spruce, can hardly be seen as being non-renewable as they are still relatively small in size and are typically used to produce products (framing lumber and pulp) which can be made readily from second growth stands. In contrast, timber in "wet belt" regions that have not been exposed as frequently to disturbance may be very old (>300 years). The large stems in these stands are much more likely to exhibit characteristics (fine grain) which are non-renewable, particularly for species such as Douglas fir and western red cedar.

12 The Faustmann and SY rotation ages tend to converge at around 16 hours from the market centre, after this point the Faustmann age is actually longer than SY. However, since there are several market centers spread across the interior landscape, most land is within 10 hours of any given market centre.

Figure 4 Soil rent dissipation under SY management with 3% discount rate



to invest back into the land, then these incentives may well be consistent with public objectives and institutions need to be designed to reflect this. This will probably entail establishing stronger property rights to the land (tenures with lengthened durations or outright privatization). However, due to the low productivity of most of the land, it appears that reforestation on much of the British Columbian interior landscape is a cost that the private sector will not incur on its own. As a consequence, maintaining public ownership of the land with tenure arrangements based on the harvesting of mature timber and regulations governing basic reforestation may be entirely appropriate. Furthermore, on these marginal lands, management by SY, after one considers various non-timber benefits, for practical purposes may be completely suitable.

Conclusion

This paper presented an alternate use for hedonic stumpage models. It showed that they can be simple and flexible in the valuation of timber throughout time. Further, because they take into consideration site specific attributes of the timber and the land, they have the potential to be very powerful and accurate. Consequently, they can be a very useful tool for a host of decisions facing forest managers. This includes decisions pertaining to the timing of harvesting, the benefits of silviculture investments and the identification of the extensive margin.

It was also shown that such assessments can also be an important input in institutional

design and forest policy formulation. In the case of British Columbia's timber institutions they were able to reveal the rent gradient over forestland throughout the interior and how that has likely contributed to the lack of private forestland in this region and perhaps the rest of Canada. They also revealed the flaws associated with existing policy based on one sized fits all SY management. The challenge, as it has always been, will be to design timber institutions in the province in a manner where private incentives match those of the public. To that end it is important to understand the incentives facing the private sector on different parts of the landscape and to design policy instruments accordingly. This applies to the management of existing stocks of timber as well as the land.

References

Alston, L.J., T. Eggertsson, and D.C. North. 1996. Empirical Studies in institutional Change. Cambridge University Press.

Benson, C.A. 1988. A need for extensive management. For. Chron. 64: 421-430.

Boltz, F., D.R. Carter and M.G. Jacobsen. 2002. Shadow pricing diversity in U.S. national forests. Journal of Forest Economics 8(3): 185-197

Brannman, L.E. 1996. Potential competition and possible collusion in Forest Service timber auctions. Econ. Inq. 34: 730-745.

Brazee, R. and R. Mendelsohn. 1988. Timber harvesting with fluctuating prices. For. Sci. 34**:** 359-372.

Bromley, D.W. 1991. Property rights regimes: formation and policy issues. In Environment and the Economy: Property Rights and Public Policy. Blackwell, pp. 136-49.

Buongiorno, J. 2001. Generalization of Faustmann's formula for stochastic forest growth and prices with Markov decision process models. For. Sci. 47(4):466-474.

British Columbia Ministry of Forests and Range. 2006. Tipsy version 3.2b [online]. Available from http://www.for.gov.bc.ca/hre/gymodels/TIPSY/new.htm [accessed 6 September 2006].

Dunn. M.A., and M.R. Dubois. 1999. Determining econometric relationships between timber sale notice provisions and high bids received on timber offering from the Alabama Department of Conservation/State Lands Division. In: Proceedings of the 1999 Southern Forest Economics Workshop, Biloxi, Mississippi, April 18-20, 1999.

Guttenberg, S. 1956. Influence of timber characteristics upon stumpage prices. Occasional paper 146 New Orleans: USDA Forest Service, Southern Forest Experiment Station.

Hansen, R.G. 1985. Empirical testing of auction theory. Am. Econ. Rev. 75: 156-159.

Hartman, R. 1976. The harvesting decision when a standing forest has value. Economic Inquiry. 14:52-58.

Heaps, T., and B. Pratt. 1989. The social discount rate for silviculture investments. B.C. Ministry of Forests and Forestry Canada, Victoria, B.C. FRDA Rep. 071

Luckert, M.K. and J.T. Bernard. 1993. What is the Value of Standing Timber?: Difficulties in Merging Theory with Reality. For. Chron. 69(6): 680-685.

Luckert, M.K. and D. Haley. 1990. The implications of various silvicultural funding arrangements for privately managed public forest land in Canada. New Forest 4:1-12.

Munn, I.A. and R.R. Rucker. 1994. The value of information services in a market for factors of production with multiple attributes: The role of consultants in private timber sales. For. Sci. 40(3):474-96.

Newman, D.H. 2002. Forestry's golden rule and the development of the optimum forest rotation literature. Journal of Forest Economics. 8(1):5-27.

VII. Summary, conclusions and future research

Timber resources remain an integral part of several regional economies in British Columbia (BC). This forest resource is rich in diversity, ranging in species, age, structure and accessibility (i.e. terrain and distance to markets). The institutions governing these resources are equally complex. Perhaps this is best displayed in the province's timber tenure system. An assortment of tenure types exist in the province, each with their own unique characteristics, history and purpose. Collectively, these tenures have been designed to meet a broad group of governmental objectives. These objectives include: encouraging investment in timber processing facilities, generating forest sector employment, maintaining community stability, collecting government revenue, promoting reforestation and supporting long-term sustainable forestry.

Balancing these objectives throughout time has proved to be challenging. This was particularly true given the softwood lumber dispute with the United States (US). Access to US markets hinged on the BC government proving that it collected "adequate remuneration" for its timber resource (which according to the US can be shown by auctioning timber through open competitive markets) and by allowing market forces to dictate forest sector activity (US Department of Commerce 2003). The BC government created the Forestry Revitalization Plan (FRP) in 2003, largely out of a desire to satisfy these US conditions. The hope was this would provide its industry with unobstructed market access to the US, but also provide the industry the flexibility needed to adapt to heightened global competition. Did these policy reforms address US concerns? If not, how so? Did they affect the generation and distribution of timber rents? Were there both winners and losers? Also, why did the reforms not go further? In particular why was publicly owned timberland not privatized?

This thesis sought to uncover some specific answers to the above questions, but also searched to identify the factors which are driving timber policies in the province more generally. However, in doing so additional questions came forth. Furthermore, a complete answer to the original set of questions in many cases was not always clear. As a consequence, this chapter summarizes my key findings and conclusions; however it also includes a section which outlines future research needs.

Thesis summary and general conclusions

The review of BC's storied forestry history in chapter 2 shows that policies pertaining to timber in the province are in a constant state of flux. However, particular policies were far more sweeping than others and had more noticeable impacts for years to come. Each of these major policy shifts seemed to be precipitated by a change in the market outlook for timber and was shaped by economic demands at the time.

Endowed with an enormous stock of old growth timber and projected shortages in other regions, at the turn of the century a newly developing province starved for infrastructure designed a system of public forest management to lure investors to develop a domestic forest processing sector. Next, Sustained Yield (SY) management and

enhanced utilization standards offered secure timber supplies to an emerging, capital intensive, post World War II pulp industry which in turn met the province's regional development goals and promoted the adoption of new technology in sawmilling. Later, an abnormally high lumber market afforded the province the opportunity to address rising environmental concerns.

Conditions did not stay static however; BC faced a completely new setting at the start of the new millennium. The natural competitive advantage of its mature timber stock had diminished as accessible supplies dwindled and technological advancements (engineered wood products, tree breeding etc.) meant that substitute products derived from intensively managed short-rotation species in other regions could now offer plentiful supplies at a potentially lower cost (Sohngen et al. 1997). On top of this, the provincial government's customary interventionist approach in the forest sector was a continued trade irritant with the US. Faced with restricted access and increased competition in its traditional marketplaces, the pressure for institutional change became unbearable.

This institutional adjustment, encapsulated by the FRP, like others in the past was born out of current economic conditions. In this case, institutions needed to adapt to allow the provincial forest sector to expand its market access and to become more efficient. Indeed, this thesis shows that in many ways the FRP and its associated legislation did exactly that; implementing long overdue reforms which had the effect of substantially increasing the wealth derived from the forest and addressing several long standing issues associated with the trade dispute. In terms of the former, foremost among these were the changes to:

1. *Utilization policies* - new 'take or pay' utilization policies which charge stumpage in a fixed manner eliminate the incentive to high grade the resource and as a result the need for command and control policies aimed at countering this distortion. This will establish the proper intensive margin, increasing the rent available from public timber (see chapter 3; Uhler and Morrison 1986; Paarsch 1993)
2. *Timber auction practices* – The size of the timber sale and the level of competition were shown to significantly impact the value of standing timber in BC (chapters 4 and 5). The province therefore stands to gain by eliminating practices which limit timber sale size and competition. This appears to be the case with the changed mandate and operation of the government's timber auction agency (see change from Small Business Forest Enterprise Program to British Columbia Timber Sales in chapter 5).
3. *Processing regulations* – traditional timber processing regulations embedded within several tenures are expensive (see chapter 5). These costs are due either to restrictions which limited where timber flowed or because of distortions caused by the tenure award process (they created an incentive to over-employ capital and labour). The government's new practise of awarding tenures solely based on price and the elimination of appurtenancy requirements tying timber from existing tenures to certain manufacturing facilities abolishes these costs. Furthermore, added freedom to close mills and transfer tenures appears, in some instances, to be fostering a more resilient industry in the long run (see chapter 3).

The above reforms, along with an administered stumpage system based on auction results, were also a necessary condition for free trade with the US (US Department of Commerce 2003). It turns out that they were not sufficient however, as softwood lumber flows from BC to the US are currently still restricted. It is difficult to say whether these continued restrictions are due to "old fashioned protectionism" (McNabb 2005) or because of outstanding issues such as sustained yield management, log export restrictions and the workings of administered stumpage systems based on transaction evidence (see chapters 3 and 4). At the very least, it seems to me the reforms have served to strengthen BC's future bargaining and legal position with the US.

The research in this thesis also revealed that the FRP significantly re-distributed timber rents, creating both winners and losers. The big winner appears to be the provincial government. Their new policies not only generate more rent but through more open competitive timber auctions they also stand to increase the amount of rent that they collect.[1] However, to some extent this came at the expense of industry and labour, as rents that were once dissipated were benefiting these groups either directly or indirectly. This is summarized below:

- Prior utilization standards which made logging companies remove lower quality logs were rent reducing. However, the pulp sector, particularly on the coast, relied heavily on these logs to furnish their mills (see chapter 3). Likewise, undersized timber sales reduced the available rent from public timber, but provided opportunities for small producers (see chapter 5).
- Uncollected rents not captured by administered stumpage systems were capitalized into the value of timber tenures held by major companies. New stumpage fees derived from timber auctions have the potential to transfer wealth away from tenure holders (see chapter 3; Binkley and Zhang 1998).
- Labour and capital lost their value as the previous tenure award process indirectly gave them a claim to resource rents. This loss has the potential to impact forest dependent rural communities as this award process was being used to retain or attract labour and capital to specific locations (see chapter 5).

Referring back to the stated goals of the FRP in chapter 1, I therefore conclude that the goals of increasing competitiveness by allowing "right sizing" and freeing timber to flow to its highest value use are on their way to being achieved (log export restrictions still hinder this process). Nevertheless, these goals, in some areas and for some parts of the forest sector, potentially conflict with the healthy forest sector and healthy community objective. They may also conflict with the goal of generating new entrants; for as economies of scale are exploited, additional entry barriers may be erected (regulated harvesting quotas and transportation costs already act as entry barriers, see chapters 4 and 5).

Moreover, further decentralization advocated in the past aimed at strengthening

1 The exception to this might be in the Fort Nelson zone where timber auctions were not subject to much competition. As a result, stumpage fees from auctions may well be lower than administered fees. See chapter 4 for more details.

private property rights over forestland (Haley 1985; Zhang and Pearse 1996) if not designed carefully could be inconsistent with other public objectives for the forest. Chapter 6 demonstrated that the purported inefficiencies in the tenure system (i.e. its lack of incentives for investment in silviculture) have likely been over-stated, as the private sector would have little incentive to perform basic reforestation activities on much of the forest estate even if given the securest form of property rights.[2] As a consequence, the traditional practise of granting rights to mature timber but not land may very well be appropriate for much of the province's forest estate (particularly lands of lower productivity in the interior region and steep, isolated regions on the coast).

On highly productive accessible sites in both regions, where intensive timber management is suitable, stronger property rights may well facilitate greater investment and innovation on the land. This could relieve pressure on existing stocks of natural forest valued for their public goods (Binkley 1997). For it is on these highly productive lands where existing interventions in the timing of harvesting (i.e. sustained yield management) are most costly (see chapter 6). The amount of rent that sustained yield dissipates is substantially smaller on steep, isolated sites with low productivity however. Maintaining sustained yield management in these circumstances may be appropriate once one considers other non-timber benefits such as carbon sequestration and the provision of wildlife habitat. Future research should be directed toward quantifying these values and incorporating them into management decisions.

Directions for future research

In my opinion, there are several other future research issues that need to be addressed. Perhaps foremost among them are the outstanding matters pertaining to the softwood lumber dispute. These fall into the following three categories, all of which are somewhat related:

1. Timber supply
2. Stumpage system and timber auctions
3. Log export restrictions

Timber Supply

A good start would be to address the question implied by Sedjo (2006); what would timber supply look like if the private sector was granted greater ownership and control over the mature stock of timber in the province? Would it choose to harvest it faster or slower than sustained yield? Several authors (Nordhaus 1992; Uhler 1991) have inferred that that private sector would liquidate timber much faster than sustained yield. However these intuitive appeals are not sufficient, particularly given recent deviations from sustained yield designed to address the mounting pine beetle infestation in the province. Can these harvest increases be justified economically? It seems to me that a robust analysis considering site specific timber characteristics, user costs and price

2 Silviculture is the practice of establishing, tending and managing forest growth. In chapter 6 it was shown that tree establishment (reforestation) on much of the interior landscape could not earn the cost of private capital.

effects is warranted. If it can be shown that SY (or other harvest targets) actually reduce timber production in Canada compared to a private market, perhaps the debate about stumpage fees is somewhat moot (Luckert 2006).

This work would also be interesting more generally as it also fits into the paradigm shift called for by Luckert and Williamson (2005). They argue, rather persuasively in my opinion, that SY attaches strong sustainability requirements to the wrong forest product (timber rather than public goods such as biodiversity). What would timber supply look like if it was constrained only by things like wildlife habitat and scenic quality rather than the even flow of timber? What impact would this have on community stability and prices in the North American lumber market?

Stumpage system and timber auctions

Related to the above, how should the province's timber auction agent, British Columbia Timber Sales, behave? Does the mandate of providing a representative sample of timber value in the province (all shapes and sizes and in all market conditions) conflict with the goal of producing an administered stumpage system that replicates a market? How do market-based administered stumpage prices respond to changes in downstream products like lumber? Does this result in similar prices and output responses at different points in the business cycle as producers in the United States? (Spelter 2006).

Further, is auctioning 20% of the timber supply sufficient to garner a competitive market price? Are spot market auction transactions efficient institutions given the specific nature of forest product manufacturing facilities? Are auctions the right mechanism for selling timber resources in all regions of the province given the presence of scale economies and high transportation costs? How might competition for BC's timber be expanded further?

Log exports

In chapter 4 it was suggested that the answer to the latter question in some cases may come by eliminating log export restrictions. If this was the final ingredient needed to resolve the softwood dispute, how might the location of timber processing change if there were both free trade in lumber and logs? Neoclassical economic theory and a previous study (Margolick and Uhler 1992), suggest that the province as a whole would benefit from such a change, but there would be both winners and losers. Is some form of compensation necessary, in order for this potential Pareto improvement to take place?

Investigating the process of institutional change

In general, any of the prospective reforms listed above will not be easy to implement politically as typically there are winners and losers and previous attempts to make reforms in these areas fuelled many public emotions (see chapter 2). Deviation from SY will inevitably be questioned from a timber supply security, community stability and sustainable forest management point of view; relaxing log export restrictions will be labelled as job exports; tenure reforms aimed at strengthening property rights face legal challenges from First Nations and members of the public will be concerned about the

effects forms of privatization have on their national heritage.

In some cases, reforms to existing institutions may not be warranted. However, in other cases change and adaptation is required as former institutions which were often put in place in response to previous circumstances are not suitable for current or future conditions. After all it is the adaptive efficiency of institutions which tend to explain a region's economic performance in the long run (North 1990). Broadly speaking therefore, future research and analysis may benefit greatly from the new institutional economics literature that North helped pioneer (Menard and Shirley 2005).

References

Binkley, C.S., 1997. Preserving nature through intensive plantation forestry: The case for forestland allocation with illustrations from British Columbia. The Forestry Chronicle 73(5): 553-559.

Binkley, C.S., D. Zhang. 1998. Impact of timber-fee increases on British Columbia forest products companies: an economic and policy analysis. Canadian Journal of Forest Research 28: 617-625

Haley, D., 1985. The forest tenure system as a constraint on efficient timber management: problems and solutions. Canadian Public Policy 11(3): 315-20.

Luckert, M.K., 2006. Property rights, forest rents, and trade: The case of US countervailing duties on Canadian softwood lumber. Forest Policy and Economics 9: 581-590.

Luckert, M.K., Williamson, T., 2005. Should sustained yield be part of sustainable forest management? Canadian Journal of Forest Research 35: 356-364.

Margolick, M., and R.S. Uhler. 1992. The economic impact on British Columbia of removing log export restrictions. In Emerging issues in forest policy, P.N. Nemetz (ed.). UBC Press, Vancouver, Canada.

McNabb, L. 2005. A BC perspective on the softwood lumber dispute. Presentation at the US - Canada forest products trade bilateral technical symposium. Michigan State University, March 7th 2005. Available from http://www.for.msu.edu/trade/ProgramPresentations.htm [accessed 22 March 2007].

Menard, C. and Shirley, M.M. 2005. Handbook of new institutional economics. Dordrect, Springer.

Nordhaus, W.D. 1992. The impact of stumpage charges on prices and trade flows in forest products, Appendix A to memorandum concerning alleged subsidies and preferentiality in the matter of certain softwood lumber products from Canada. INV. C-122-816. International Trade Administration, US Department of Commerce, Washington.

North, D.C. 1990. Institutions, institutional change and economic performance. Cambridge, University Press.

Paarsch, H.J., 1993. The effect of stumpage rates on timber recovery. Canadian journal of economics 26(1): 107-120.

Sedjo, R. 2006. Comparative views of different stumpage pricing systems: Canada and the United States. Forest Science 52(4): 446-450.

Spelter, H. 2006. If America had Canada's stumpage system. Forest Science 52 (4): 443-445.

Sohngen, B., Mendelsohn, R., Sedjo, R., Lyon, K. 1997. An analysis of global timber markets. Resources for the future. Discussion paper 97-37.

Uhler, R.S. 1991. The great subsidy debate. In Canada United States trade in forest products. Edited by R.S. Uhler. UBC Press, Vancouver, Canada.

Uhler, R.S., P.D. Morrison. 1986. Utilization standards and economics efficiency in British Columbia forests. Forest Economics and Policy Analysis Project. Report 86-1. University of British Columbia, Vancouver.

U.S. Department of Commerce. 2003. Proposed analytical framework for softwood lumber from Canada: Discussion Draft". Washington DC.

Zhang, D., Pearse P.H., 1996. Differences in silvicultural investment under various types of forest tenure in British Columbia. Forest Science 42: 1-8

Stellingen behorende bij het proefschrift

Essays on the economics of British Columbian timber policy

Kurt Niquidet

1. Institutions governing forest use in British Columbia have been shaped by changing economic demands, however policy maker's response to these changing demands have been constrained by past institutions.

2. The most recent reforms to forest tenure, termed the Forestry Revitalization Plan, created both winners and losers in the British Columbian forest sector. The forest owner (the provincial government) largely benefiting at the expense of labour and capital employed in forestry.

3. Administered timber pricing formula based on transaction evidence models coming from timber auction results are biased if they do not include no-bid information.

4. Property rights to forest resources in British Columbia have been endogenously determined; becoming weaker as the rental value of the timberland decreases.

5. Rent dissipation attributed to maximum sustained yield policies is highest on the most productive land close to processing facilities. As a consequence the pressure for policy change will be greatest on these lands.

6. Restricting large integrated firms from timber auctions has little impact on revenue, provided re-sale opportunities are made. However, awarding timber based on a combination of revenue, manufacturing and employment criteria significantly lowers revenue.

7. Timber sale competition can be enhanced for most of the province by allowing log exports.

8. Writing a PhD thesis is much like a baseball game; "it ain't over till it's over." – Inspired by Yogi Berra

9. Genetic Drift is deterministic.